

**The Comparative Anatomy of
Australian Mammals**

PART IV.

**THE GENITO-URINARY SYSTEM
IN
MONOTREMES AND MARSUPIALS**


MacKenzie



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THE
GENITO-URINARY SYSTEM
IN MONOTREMES AND
MARSUPIALS

BY

WILLIAM COLIN MACKENZIE, M.D., F.R.C.S., F.R.S.E.

Member of the Council of the Anatomical Society
of Great Britain and Ireland.

Assisted by

WILLIAM J. OWEN,

Member of the Royal Society of Victoria.

With an Introduction by

DR. MARGARET McLORINAN,

Hon. Gynecological Surgeon, Queen Victoria Hospital for Women,
Melbourne.

Acting Hon. Surgeon Women's Hospital, Melbourne.

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INTRODUCTION.

It must be obvious even to the most casual medical observer that, from the functional point of view, changes of a retrograde nature are taking place in the female generative organs, and invariably in any metropolitan hospital, whether general or special, there is always a long waiting list of pelvic operations, and an overcrowded state of the gynecological wards. Although operations for new growths, whether fibrous, cystic, or malignant, are frequent enough, nevertheless it is surprising to note that the majority of the gynecological cases operated on are dependent on "faulty" labour, as, *e.g.*, displacements, infections of various kinds, and lacerations with prolapse. The prime function of the female generative organs is that of reproduction of the species. We have set ourselves as ideal or standard that the function of reproduction should not cause the mother's death, or injure her health, and that the child be born alive and capable of extra uterine existence. Can, however, a function so perilous be called a "normal" one that in spite of the best care is frequently attended with fatal results, leaves at least a quarter of women more or less invalided, and a majority with permanent anatomic changes of structure? We begin to ask ourselves whether placental formation with the risks of disease and haemorrhage and the retention of the human foetus in utero for nine months are really so beneficial as is taught. In contrast with this, we find in the "selected" marsupial, the wombat, that an embryo 2 c.m. long, whose intra-uterine life probably is not more than 21 days, can be placed by its mother on a nipple in the pouch, moving, breathing, and obtaining its nourishment till it can leave the pouch and obtain food for itself, ultimately developing into what is probably the most perfect physical type amongst mammals. Yet no instances are on record of monstrosities in Phascolomyidae, nor can lacerations or other abnormalities be detected in the genital organs immediately after the birth of the embryo. Since

the introduction of the antiseptic system, growths are removed, lacerations repaired, and displacements corrected by numberless operations, but these surgical procedures bring us no nearer to cause. Have we yet solved the true position of the uterus or what are the main supports that hold it in its so-called "normal" position? We correct cases of retroflexion of the uterus by various methods of shortening the round ligaments without having clear notions of the ancestral history of these structures. Nor does a study of the masses of literature of philanthropic workers and social reformers who preach, and often from political and other motives, about the decline of birth rate and race suicide, throw any light on the retrogression, since they invariably argue from the moral aspect, and take no consideration of the all-essential alterations in structure and function resulting from environment. Organs and their functions are adjusted to conditions of existence.

If pelvic surgery is to be placed on a scientific basis, that basis must be one of comparative anatomy. Just as an architect obtains the knowledge necessary to design a public building by mastering firstly the designs of a one-roomed house, so similarly should the gynecological student have a knowledge of the ancestral history of the function and structure of the human female organs. To obtain that knowledge, no country in the world offers such an exceptional field as Australia, since we have here, and limited to but two Orders, animals presenting such differences of development that at one extreme we have the egg-laying Monotremes (*Platypus*, *Echidna*), and at the other the placental Peramelidae (*Bandicoots*).

It is the opinion of many gynecologists that internal secretions play a much more important part in affections of the female pelvis than is usually taught, and, as Beidl points out, the activity of the sex organs is associated with the profoundest problems of general biology and embryology. Dysmenorrhoea is still being treated by various

operative methods and antispasmodic drugs with poor results, and similarly with eclampsia, concerning the cause and treatment of which we know so little. If these and other conditions, such as uterine inertia, could be definitely associated with some alteration in the internal secretory mechanism, how much more rational would the treatment become ; and similarly with fibroids whose presence is possibly associated with diminution or excess of internal secretions. The announcement last year by the writers, before the Royal Society of Victoria, of the discovery in the lowest mammal, platypus, of three new internal secretory glands, viz., parathymus, cervical sex gland, and the scapular gland, proves to us that the physiology of glandular secretion is still in its infancy. In this volume the discovery of the sex gland, present in both male and female Platypus, is announced in the Marsupial, and it is interesting to note that it is best developed in the male wombat, which is provided with two large pairs of these structures. What is their function ? Are they present in the human male and female ? If not present, is their absence physiological or pathological ?

In the Tasmanian Devil a direct branch of the vagus nerve can be traced into the broad ligament where a plexus is formed for distribution to ovary, tube, and uterus. A direct connection between the female generative organs and the brain opens up a new field in gynecology, and may it not help to explain the many gastric attacks, bilious headaches, backaches, and other symptoms so familiar to us all. The anatomy of the human vagus nerve can scarcely be regarded as satisfactory.

The discovery by Professor Keith that in the Australian echidna there is a true and direct union between nerve and muscle fibre in the sino-auricular node, provided the key to that system of tissues in which the human heart beat arises, and by which it is propagated throughout auricles and ventricles. We also know that there are definite

control areas or "locks" along the gastro-intestinal tract. It is reasonable to suppose that a pace-regulating system exists in connection with the uterine muscle to which the vagal relationship noted in connection with Tasmanian Devil would lend support. In other words, so-called loss of uterine muscle tone need not necessarily be generalized, but be due to a local derangement. As regards the symptoms associated with displacements of the uterus, I feel that the cause of these is rather neuro-muscular defect than the results of faulty position. Such a causation possibly operates in the uterine inertia of pregnancy. In the Kangaroo, which might be regarded as an erect-position animal, the right and left uteri lie in close relationship normally with the ventral wall of the rectum.

The description given in this volume of the round ligament is an important contribution to the etiology of that structure. The intra-pelvic fibro-muscular band is seen primarily to be independent of the extra-abdominal "round ligament" or cremaster muscle which originates from the abdominal muscles, and is concerned with the nourishment of the foetus in the pouch. The atrophy of the cremaster is associated with the disappearance of the pouch in higher mammals and the transference of the mammary glands from an abdominal to a thoracic position. There is no etiological support for the operation of the suspension of the uterus, nor in the marsupial could one regard as the essential uterine support the, sometimes slender, inguinal fold, corresponding to the human intra-abdominal portion of the round ligament with its involuntary muscle fibres. The site of suspension is the iliac fossa, where we see the broad ligament spreading out into a fan-shaped arrangement of fibro-muscular tissue. A study of the marsupial suggests that iliac suspension rather than ventral or inguinal would be etiological correct for the human uterus.

An examination of the ovary of the Wombat is of great interest to the obstetric surgeon.

Three structures are regarded as being concerned in the internal secretion of the ovary, viz., the follicles, the corpus luteum, and the interstitial tissue. Evidence of the function of the corpus luteum is still unsatisfactory. Born and Fränkel believed that its function was to establish the ovum in the uterus and promote its development, while according to Prénant, quoted by Beidl, its internal secretory function consists in inhibition of ovarian activity, and more especially in the prevention of ovulation during pregnancy. The ovary of the wombat is characterized by the presence of a firm swelling sometimes half the size of the remaining ovarian tissue, which on examination shows the structure of a typical corpus luteum. The wombat, it must be borne in mind, is non-placental, and the intra-uterine life of the embryo probably rarely exceeds 21 days. Furthermore, the mode of nourishment of the embryo in the pouch is not different to that of other marsupials. At a later date I hope to publish experimental data concerning this structure.

In this volume for the first time the structural anatomy from the functional standpoint of the genito-urinary system of the Australian Monotremes and Marsupials is systematically described. I have only touched on some of the many problems suggested. Much more might be written, as for instance, on Nature's experiments in unification of the Müllerian ducts and their significance in explaining human abnormalities. To the student of gynecology and obstetrics wishing to understand the basic principles that underlie the structure and development of the human genito-urinary system, a knowledge of this work is essential. Furthermore, one feels that the description of the anatomy of the human female pelvis, as at present taught in our medical schools, is badly in need of revision, not from the structural, but from the functional or comparative standpoint.

MARGARET McLORINAN.

EXPLANATORY.

Many papers descriptive of the structural anatomy of the genito-urinary system in Australian Monotremes and Marsupials have been written. The most important early work was carried out by Sir Everard Home, brother-in-law of the renowned John Hunter, on which Richard Owen's work was largely based. Notable contributions have been made by Professor J. P. Hill, the distinguished embryologist, on development; by Fletcher, on Macropods; and Forbes, on Koala; and in addition many American, French, and German authorities may be consulted, notably Semon. A separate appendix dealing with bibliography will be issued later. In this work the subject has been approached from the functional side, so that its importance may be brought to the notice of the student in medicine and surgery. The importance of a knowledge of the anatomy of the Australian fauna to the physician or surgeon cannot be over-estimated. Zoology as at present taught is regarded by the average medical man as of academic interest only. Nevertheless if Medicine is to become a science it must be along the lines of comparative anatomy, not so much structural as functional. In the male section the description of the ductless "sex" gland should prove of particular interest to the physician, and similarly the inguinal and prostatic regions to the operating surgeon. Thanks is expressed to Mr. Le Souef, F.Z.S., the distinguished Director of the Melbourne Zoological Gardens, for his assistance in the collection of specimens and information on various questions of Natural History; Miss O. Hine, for help in the preparation of the manuscript; and Mr. E. Hill, of the Goulburn Valley, for many kindnesses. Some of the illustrations are from the pen of the distinguished Australian etcher, Mr. Victor Cobb, of Melbourne.

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THE FEMALE GENITO-URINARY SYSTEM IN MONOTREMATA. PLATYPUS AND ECHIDNA.

Simplification can be regarded as the characteristic of the female generative system in this egg-laying order of mammals. In both Monotremes the left ovary is large and well defined, but the right in *Platypus* is small, and may be indistinguishable from surrounding tissues. Thus it is interesting to note that in the "lowest" mammal the left is the "selected" side. "In my experience in the human disease is more common on the right than on the left side, and I think where one ovary or tube had to be sacrificed, this should be the right" (Margaret McLorinan). Free mobility of the ovary and tube, as of the intra-abdominal testes, characterizes the Monotreme. The efferent canal may be said to consist of two portions, viz., a proximal or oviduct and a distal or uterus. The uterus, together with the ureter, open into the commencement of the urogenital canal, and this latter in turn opens with the rectum into the common vestibule or cloaca.

(a) PLATYPUS.

The ovary, oviduct or Fallopian tube, and uterus on each side are suspended on a double fold of peritoneum, the broad ligament of higher mammals which laterally is traced to the ilio-lumbar region—the upper, outer, or lateral attachment. This attachment curves round the distal extremity of each kidney and ventral to the two lower ribs, but there is not the intimate relationship with the kidney met with in *Echidna*. Limiting the attachment are two well-defined free margins, viz., an outer, thin, though tough and fibrous, passing ventral to the last rib, and an inner thicker one defined by the genital vessels

PLATYPUS AND ECHIDNA.

passing mesial to the lower or distal pole of each kidney. The length of the outer margin or fold is 1.5 cm., and of the inner 2.5 cm. The distance between each free margin is 4 cm. The broad ligament gradually narrowing on each side is traced downwards and inwards ventral to the psoas minor muscle over the brim of the true pelvis on the side of which it disappears. There is not the visceral pelvic mobility noted in marsupials, and the width of broad ligament ventral to the psoas may be only 1.5 cm.

Ovaries.—These are two in number—one on each side—placed at the upper lateral part of each broad ligament. They swing quite freely in the abdominal cavity, not being contained in a marsupium or pocket as in Koala, and are readily seen when the abdomen is opened ventrally. Mobility of the ovaries as is the case with the abdominal testes can be regarded as characteristic of the Platypus.

There is a marked difference in the size of the two ovaries. The left, the larger of the two, is an irregularly granular body measuring 2-2.25 cm. in greatest length and 1 cm. in greatest width. The right, or smaller ovary, is smoother, and may be seen with difficulty. An average measurement would be .75 cm. long and .25 cm. broad. The fibrous (lateral) band forming the boundary of the lateral attachment of each broad ligament runs to the outer pole or extremity of the ovary, and from the inner pole of the ovary another fibro-vascular band is traced in along the upper limitation of the broad ligament to the junction of the oviduct and uterus, finally disappearing on the uterine body. The length of the latter band is 1.5 cm.-1.75 cm. By means of these fibrous bands a support is given to the ovary so that its relation to the abdominal extremity of the oviduct is maintained. The upper dorsal or proximal surface of the ovary has a more fibrous covering than that of the lower which is in relation with the orifice of the oviduct.

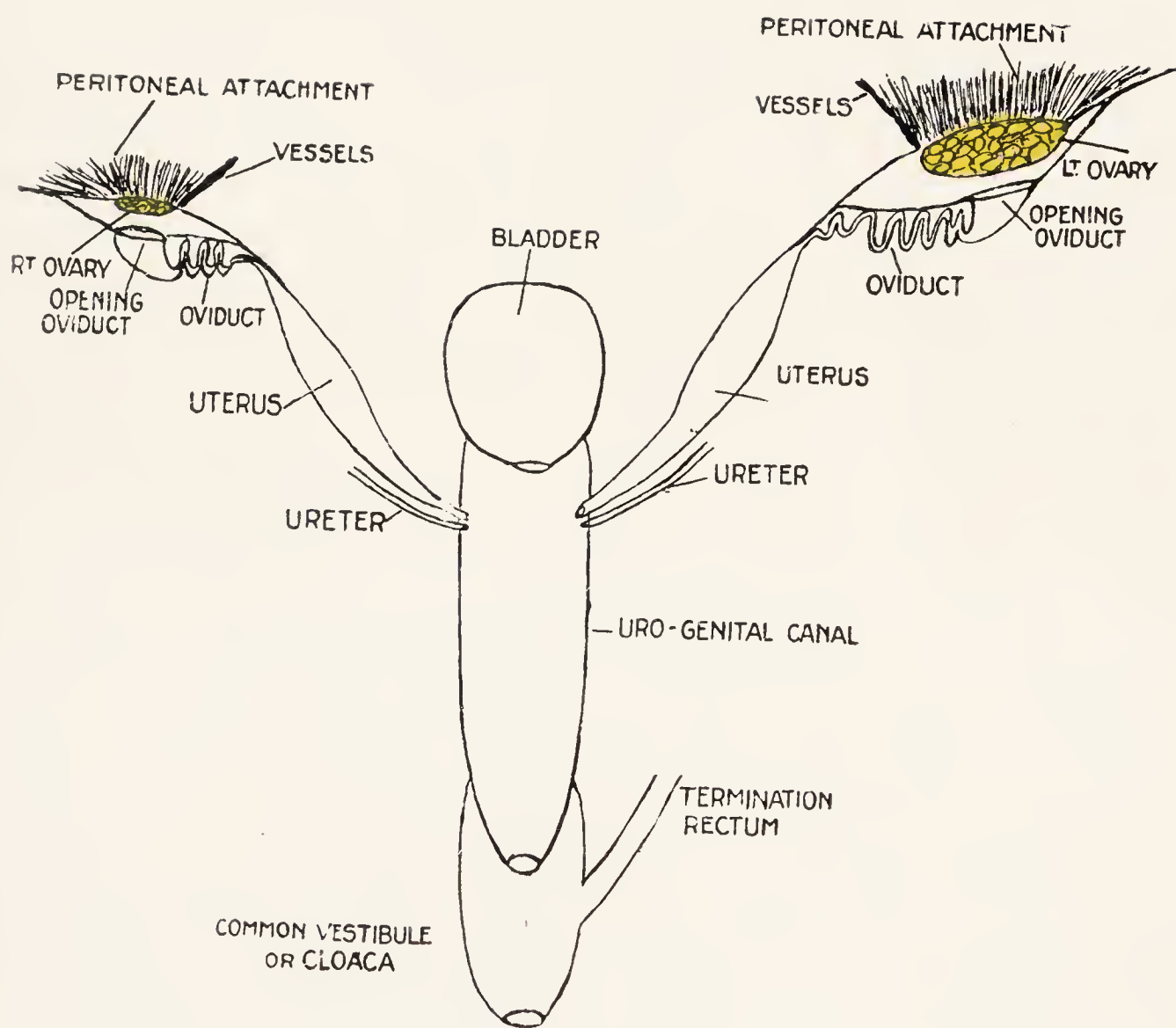


Fig. 1

THE FEMALE GENITO-URINARY SYSTEM IN MONOTREMES
(Diagrammatic from Platypus).

PLATYPUS AND ECHIDNA.

Oviducts or Fallopian Tubes.—These are two in number, one on each side, placed on the ventral face of the lateral aspect of the broad ligament just below and ventral to the ovary of the corresponding side. Convolution is characteristic of the oviduct of the Monotreme, and in this way great length within a limited area is effected. Undissected the greatest length of the oviduct is 2.5 cm. The distal or abdominal extremity of each oviduct presents an elongated slit about 1-1.25 cm. long, which is devoid of fimbriae, and this slit is held in juxtaposition to the corresponding ovary in the following manner. As stated above, from each extremity or pole of the ovary a fibrous band stretches, the outer to the abdominal wall in front of the last rib, and the inner to the upper surface of the uterus. Not only do these support the ovary in position, but form suspensory lines for the Fallopian tubes since from the extremities of the orifice forming the abdominal extremity of the tube a band passes to the outer and inner ovarian bands. The band passing from the outer extremity of the slit measures .5 cm. and that of the inner .3 cm. in length, and they may be said to form suspensory swings for the oviduct. To the inner band fine processes may be traced from the convolutions supporting them and giving these a somewhat radiating arrangement, although in the Echidna the convolutions are more bunched. An area of broad ligament is seen between the oviduct and ovary, which measures when moderately stretched 1.5 cm. in length and 1 cm. across. The outer portion of the oviduct terminating in the slit is a fibrous pouch, measuring about 1.5 cm. in length and 1 cm. wide. The length of the left oviduct when spread out is 5-9 cm. and width .5 cm. The inner or uterine portion of the oviduct does not merge gradually into the uterus. The point of junction is well defined, and the uterine orifice of the duct will only admit a fine horsehair probe. The oviduct is shorter on the right than on the left side, and the abdominal opening or slit on the right side is rarely more than .3 cm. in length.

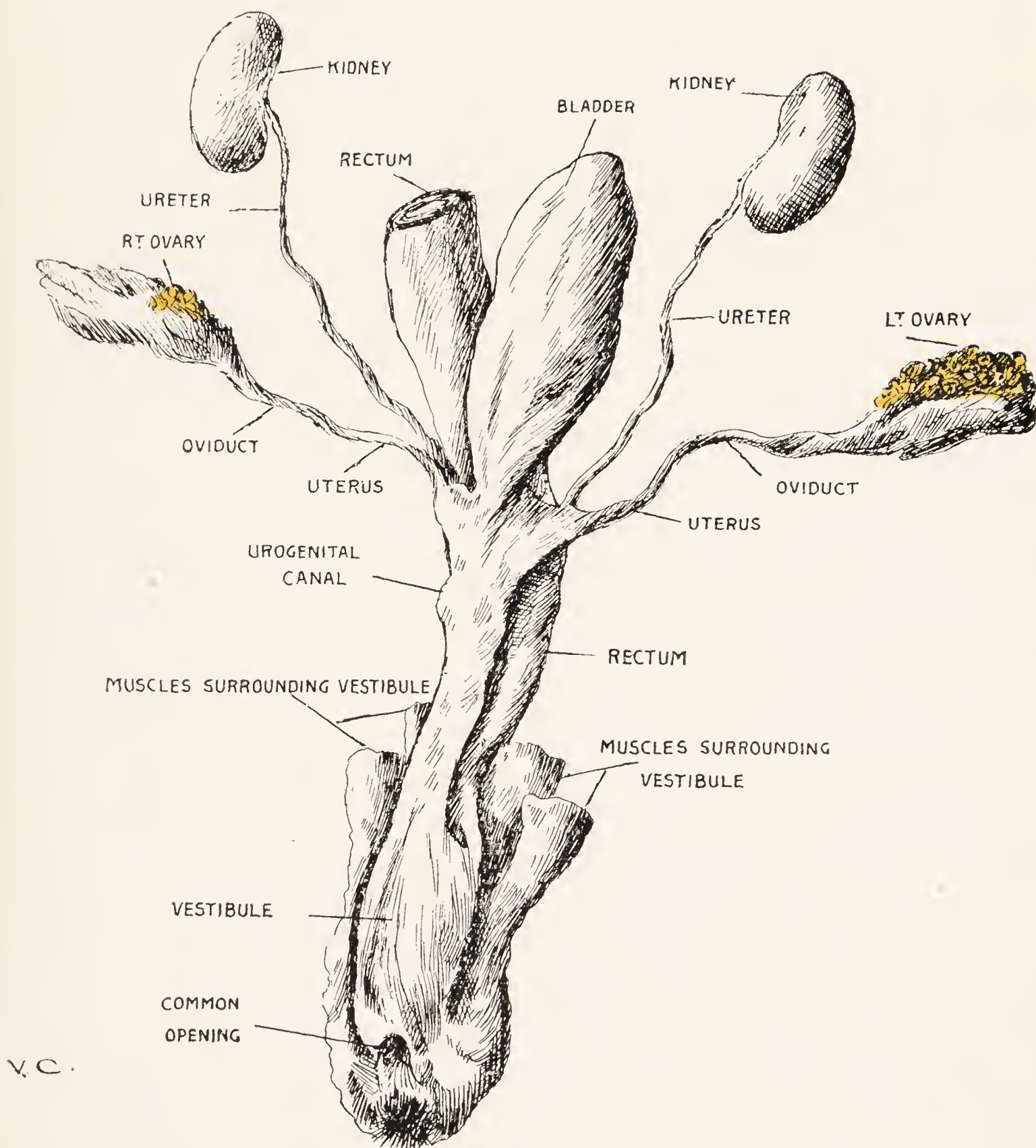


Fig. 2

THE FEMALE GENITO-URINARY SYSTEM IN PLATYPUS
(Ornithorhynchus Anatinus).

PLATYPUS AND ECHIDNA.

Uteri.—These are two in number, one on each side, extending along the upper free margin of the broad ligament, ventral to the psoas minor muscle and the iliac vessels, from the inner or mesial extremity of the Fallopian tube to the urogenital canal. The left uterus measures 5-6 cm., but the length of the right side is slightly less. As in the case of the marsupials, two portions of the uterus may be recognized, viz., a proximal portion or body and a distal, cervical, or sphincteric portion. The length of the former ordinarily is about 3-4 cm. and the greatest width .75 cm., while that of the cervical portion is 1.5 cm.-2cm. and greatest width .25 cm.-.5 cm. The interior of the body is soft and somewhat spongy, while the wall of the cervix is firmer, and the interior rugous owing to the presence of longitudinal folds. Towards its termination the cervix uteri narrows, and after running in the lateral wall of the urogenital canal for about .3 cm. forms a narrow projection .5 cm.-.75 cm. long into the interior of the proximal part of the canal. On this projection two orifices are noted, the upper or more proximal being that of the uterus and the lower or distal being that of the ureter, so that the genital orifice in Platypus is placed between the sphincter of the bladder and the ureter. The bladder in Platypus is small, rugous outside, and markedly rugous within, and measures in an adult 1.75 cm. long and 1.5 cm. across. We have never found urine in the bladder of the Platypus. It does not, as in higher mammals, receive the ureters, and opens below into the proximal portion of the urogenital canal, the orifice being guarded by a sphincter.

Urogenital Canal.—This lies dorsal to the symphysis pubes, and opens below into the cloaca or common vestibule. It measures 4-5 cm. long and width is .5 cm. Its first or proximal 1 cm. is wider than the rest, and the thickness of the wall here is .25 cm. Into this proximal portion open the bladder, cervixes uteri, and two ureters. The

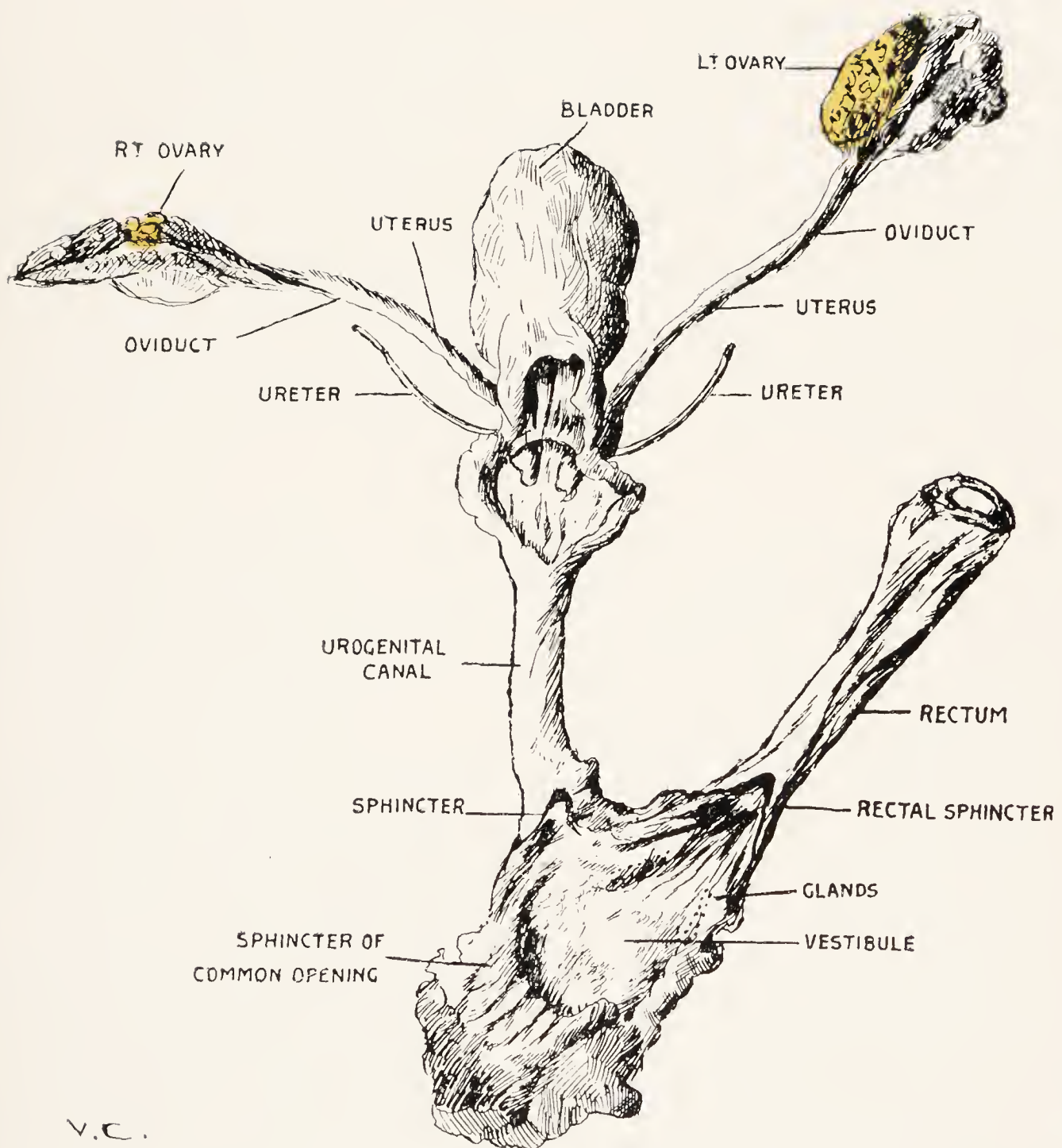


Fig. 3

THE FEMALE GENITO-URINARY SYSTEM IN PLATYPUS.
 (Bladder, Urogenital Canal, and Vestibule have been opened)

PLATYPUS AND ECHIDNA.

rest of the canal is more uniform in width, and the interior is rugous owing to the presence of longitudinal folds. The termination in the common vestibule is narrow and guarded by a sphincter, and is distal and ventral to the intestinal termination. Opposite the termination of the canal on each side a rounded body is seen which corresponds to the Cowper's gland of the male. Each has a well-defined duct, which is lined by a double layer of cells, and the gland is of the compound alveolar type.

The Common Vestibule or Cloaca receives the opening of the urogenital canal and rectum, both of which are guarded by sphincters. It measures 3 cm. long and 2 cm. in greatest width, and its common orifice is guarded by a sphincter (*cloacal sphincter*).

(b) ECHIDNA.

Though the general arrangement of the genital organs is similar in the female Echidna and Platypus, there are certain important characteristics in the Echidna which may be considered as follows :—

(a) There is less mobility of the genital system in Echidna than in Platypus, and although ovary, duct, and body of the uterus can be raised from the dorsal wall, the cervix uteri can be regarded as fixed.

(b) The lateral or outer attachment of the broad ligament is in the ilio-lumbar region, and the ovary and tube are placed in relation with the distal extremity of each kidney. The inner or vascular band of attachment seen in Platypus cannot be defined, but the outer or fibrous band (which, like the oviduct and ovary, is often found associated with fatty deposits) may be traced round the convex outer border of the kidney, almost reaching to the diaphragm. The great point is that the outer attachment of the broad ligament, together with the tube and ovary, are closely applied to the distal pole of the kidney on each side.

PLATYPUS AND ECHIDNA.

(c) The greatest width of the broad ligament, *i.e.*, at ovary and oviduct, may be not more than .7 cm. to 1 cm., gradually narrowing to .25 cm. at the uterus. It lies ventral to the psoas minor muscle, but is not traced into the pelvis.

(d) The method of suspension of tube and ovary is similar to that of Platypus. The oviduct on each side is convoluted, though the convolutions are more bunched together. There is the same saccular arrangement at the termination of the oviduct, and the abdominal opening of the duct is well defined.

(e) The ovary is well defined on both sides. There is not that disparity in size between the small right and larger left seen in Platypus.

(f) The uterus presents on each side, as in Platypus, a well-defined body and cervix, but in the Echidna the cervix uteri is immobile, being closely applied to the ventral wall of the rectum.

(g) The bladder is larger than in Platypus, but the ureters open, as in Platypus, into the urogenital canal, and not into the bladder.

(h) Into the proximal portion of the urogenital canal open the uteri, ureters, and the bladder, but the arrangement in Echidna is somewhat different to that of Platypus. Dorsal to the sphincter of the bladder is a well-defined pocket, and lateral to the pocket on each side is a slight prominence denoting the well-defined opening of each cervix uteri. Mesially placed on the dorsal floor of this proximal portion of the urogenital canal is a well-defined papillary elevation, and at the side of this on each side the ureter opens. From the papilla a medium raphe runs down the canal, and there are also two lateral raphes noted, and thus four channels are defined, the inner for the ureters and the outer for the uteri.

PLATYPUS AND ECHIDNA.

(i) The glands corresponding to Cowper's gland in the male are present as in *Platypus*, one on each side, but are about half the size.

(j) Lying ventral to the distal part of the urogenital canal in *Echidna* is a well-defined clitoris. This is 2 cm. long and .5 cm. broad, and the base of attachment is about 1 cm. from the termination of the urogenital canal in the cloaca. By means of three fissures four separate papillae are noted at its termination. The cloaca or common vestibule is well defined, as in *Platypus*, and into it open the intestinal and urogenital canals. It is interesting to note that there is complete absence in *Echidna*, as in *Platypus*, of a ventral fold from the broad ligament suggesting the round ligament of higher mammals, and this, in spite of the relative immobility of the uterus.

THE FEMALE GENITO-URINARY SYSTEM IN MARSUPIALS.

Amongst the Marsupials the varied experiments by Nature on unification of the Müllerian ducts can be studied. This is especially noticeable in connection with the vagina, since a condition of uterus, tube, and ovary similar to the Marsupial may be frequently found in Man. The efferent ducts on each side (tube and uterus) approach and unite in the mid line. This takes place before the ducts themselves open into the urogenital canal. The portions above the union on each side become oviducts (Fallopian tubes) and uteri of higher mammals and below vagina. The development of the vaginal canal is unique in Marsupials, and makes an examination at first extremely difficult. Instead of attempting to approximate the ducts further in the direction of the urogenital canal, Nature found it easier to short circuit, and to a similar attempt at short circuiting the caecum and appendix probably owe their existence. A new median vagina or vaginal caecum was formed, and the various grades of its extension backwards to the urogenital canal may be studied in different members of the order. The median vagina finally opens into the urogenital canal, with gradual disappearance of the lateral vaginal canals, as may be studied in *Trichosurus*. Thus we see why vaginal "malformations" are less frequently met with than uterine ones (M. McLorinan).

THE BROAD LIGAMENT IN MARSUPIALS.

(1) GENERAL PLAN.

Around the question of the mode of suspension of the human uterus lie many problems of surgical interest. That our knowledge of this is at present unsatisfactory is shown by the fact that the operations for backward human uterine displacement alone are said to number more than three score. Hence any investigation that tends to throw light on the evolution of the suspension of the human uterus is of more than academic interest. On this question of suspension, and especially that of the evolution of the round ligaments, the pelvis of the female Marsupial is of the utmost importance for examination; and, furthermore, the "erect" attitude assumed by the Kangaroo must be borne in mind. On opening the abdomen of the female Marsupial and examining the pelvis from the ventral aspect the ovary, fimbriated apron, oviduct, and uterus, together with the commencement of the urogenital canal, are seen, on each side, to be suspended by a double fold of peritoneum (or mesentery) continuous with the general peritoneum of the dorsal wall, which stretches across the pelvis from one iliac fossa to the other, and corresponds to the broad ligament of anthropoids and Man—that for the organs on the right side being known as the right broad ligament or mesentery, and that for the left side the left broad ligament or mesentery. This broad ligament or mesentery is comparable to other mesenteries found in the abdomen as, for example, the mesonephron of the left kidney in Koala, mesocolon of the left colon, the mesentery of the small intestines, and it is always necessary to bear in mind that these organs, though invested by peritoneum, are not within the general

BROAD LIGAMENT.

peritoneal cavity. From the lateral or iliac attachment, the broad ligament—the upper or ventral edge of which is free—is traced inwards or mesially on each side ventral to the psoas minor muscle and brim of the true pelvis, deeply into the true pelvis, gradually narrowing on the front of the sacrum and coming into close relationship with the rectum suspended on its now tapering mesentery or mesocolon. At its outer, iliac, or lateral attachment the broad ligament tends to become diffused or fan-shaped, by which extra strength is ensured, and two folds or margins of this attachment are noted, viz., an upper proximal or vascular fold containing the genital vessels, and a lower, distal, or “inguinal” arising from the ventral face of the broad ligament and passing to the inguinal region on the peritoneum of which it disappears. A more mesial and dorsal fold or prominence is noted corresponding to the ureter. Passing from the uterus towards the iliac attachment strands of involuntary muscle are seen to be diffused on the broad ligament, including both the proximal or vascular and distal or inguinal folds. This inguinal fold which is present in all the Marsupials, but is especially well marked in Wombat, represents the genesis of what is known as the round ligament of the human uterus. In the human the round ligament is described as arising from the upper and outer part of the uterus, and after traversing the inguinal canal terminates externally at the mons veneris. In Alexander’s operation for shortening the ligament the incision is an external one at the inguinal region. In the female Marsupial we have present externally, between the two epipubic bones on the lower portion of the abdominal wall, the pouch and the mammary gland. From the pouch on each side passes the broad powerful band of muscle—the cremaster—which is traced to the inguinal region, finally passing outside the peritoneum to the anterior superior spine of the ilium, and is seen to arise from the transversalis and internal oblique muscles. In

BROAD LIGAMENT.

other words, this origin of the cremaster from the internal oblique and transversalis is the cause of the arched arrangement of these in the inguinal region, but owing to the powerful nature of the cremaster which crosses the inguinal area corresponding to peritoneum and transversalis fascia, no weakness results. The inguinal band coming from the front of the broad ligament has no connection with the cremaster muscle in the Marsupial. Traction on the cremaster has no effect on the broad ligament, and, furthermore, traction on the inguinal fold tends rather to retain the ovary in relation with the iliac fossa than elevate the corresponding uterus from the pelvis. With alteration of the position of the mammary gland, and disappearance of the pouch in higher mammals, the cremaster, a voluntary muscle, atrophies, and what we really pick up externally in the human inguinal region is the atrophied remains of the cremaster. This, of course, like the Marsupial cremaster in the inguinal region, has the the peritoneum stretched tightly over it, and the effect of traction would appear to be really due to that factor. Primarily, then, the inguinal fold or round ligament is a zygotic fold or stay acting rather on the ovary than on the uterus, and into this involuntary muscle has spread from the uterus. Its use would appear to be to maintain the ovary in relation with the iliac fossa, and also the utero-ovarian relation of distance, approximating the parts during the passage of the fertilized ovum. There is no internal abdominal ring in the female Marsupial.

(2) MODIFICATIONS.

(a) *Koala*.—As in the case of Wombat, the ovary is not seen on the dorsal surface of the broad ligament on everting its upper free margin as in other Marsupials. Its mobility, like that of the Wombat, is limited, and it might almost be regarded as an organ dorsally fixed in the iliac fossa. Its position can be determined by palpa-

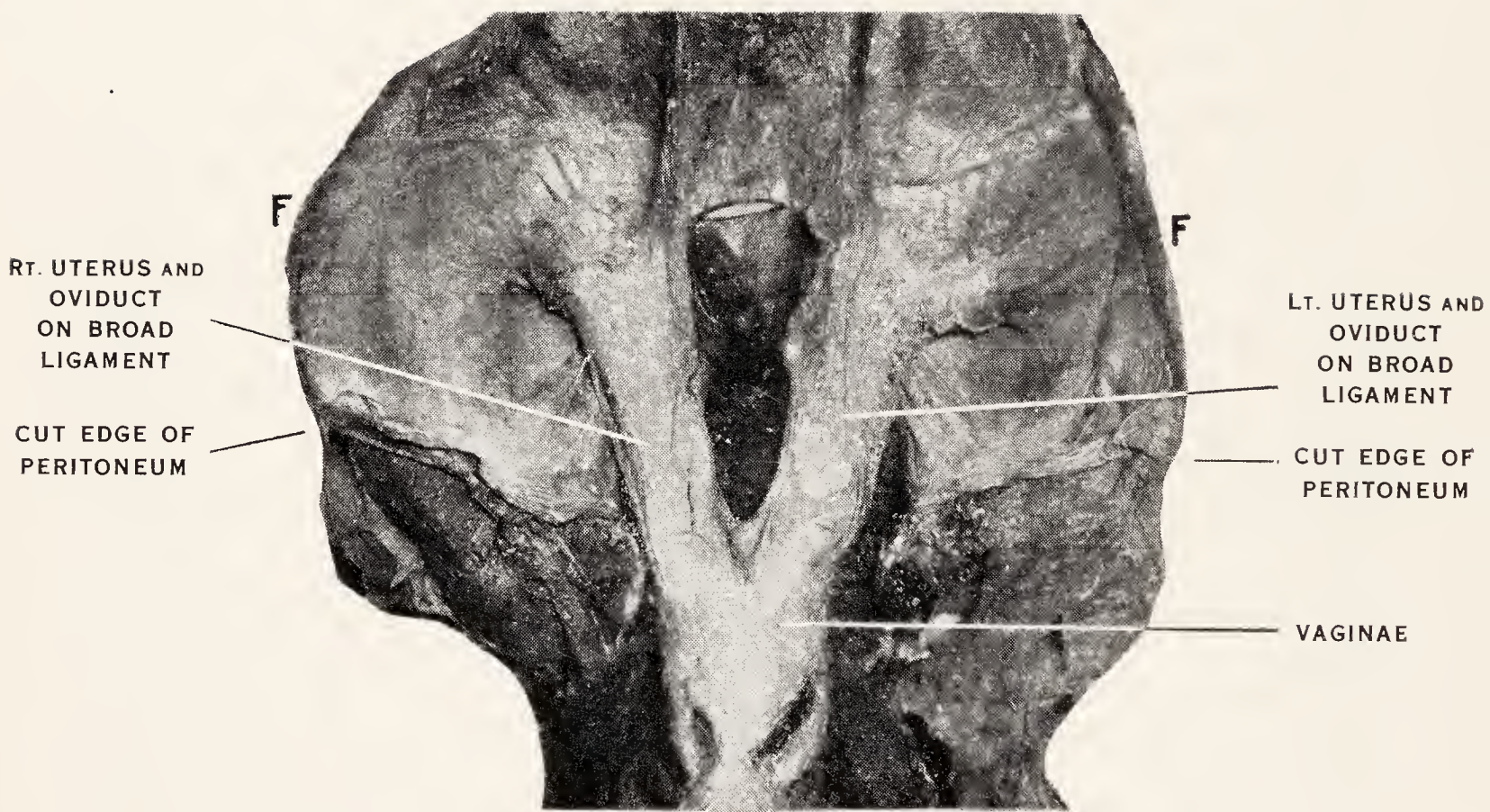


Fig. 4

DORSAL WALL OF PELVIS, KOALA, TO SHOW METHOD OF ATTACHMENT OF BROAD LIGAMENTS IN ILIAC FOSSA (F).

On each side the Ovary and Fimbriated Apron are hidden in the Ovarian Marsupium. Placed mesially is the Rectum.

BROAD LIGAMENT.

tion. On the dorsum of the broad ligament ventral to the psoas, however, the opening of a fossa—*ovarian marsupium*—is seen, into which in a well-developed adult the tip of the little finger may be inserted. This pouch lodges the ovary and fimbriated apron. The pocket is formed by a fine peritoneal fold which extends from the peritoneum over the ureter to that over the genital vessels and the outer part of the free upper margin of the broad ligament. From this pouch the ovary, fimbriated apron, and the other extremity of the oviduct may be delivered by gentle coaxing. The inguinal or round ligament fold is well developed, and the outer or iliac “attachment” of the broad ligament is distinctly fan-shaped, and measures between the extremities about 5 cm.

(b) *Wombat*.—As in the case of Koala, the ovary is not apparent when the pelvis is examined from the ventral aspect. It might almost be regarded as a dorsally fixed organ in each iliac fossa, being closely related to the front of the iliacus muscle near the iliac crest. The peritoneum and involuntary muscle form a somewhat dense thickening over it. On raising the broad ligament from the dorsal wall opposite the psoas and brim of the pelvis the free edge on each side is seen to correspond to the highly developed oviduct. The broad ligament here is wide, and the breadth may equal 7 cm. Owing to this laxity the broad ligament gives the appearance of lying collapsed on the dorsal wall with its apparent “free” edge forming a horseshoe extending from the outer edge of each uterus internally to the inguinal region externally. This edge is seen to be formed by the peritoneal fold, designated the inguinal ligament, which passes from the ventral face of the broad ligament on each side to the inguinal region. The total length is about 12-13 cm. The portion of the fold between the inguinal region and the thickened peritoneum over the ovary, with which it is connected, is the better-defined portion

BROAD LIGAMENT.

of the fold, and measures 6 cm. long, with greatest breadth near the ovary of 3 cm. The portion of the inguinal fold between the ovarian covering and the upper part of the outer edge of the uterus lying on the ventral face of the broad ligament is not so defined. As in Koala, on the dorsal aspect of the broad ligament on each side an opening is seen just admitting the tip of the little finger ventral to the psoas muscles. It is formed by a fold of peritoneum—dorsal fold—passing from the peritoneum over the oviduct to that over the ureter. By this means a sac or pouch is formed in which the large ovary and fimbriated apron are felt; and, unless their covering be removed, these latter structures must be expressed through the orifice for purposes of examination.

(c) *Macropodidae* (*Kangaroos and Wallabies*).—Whilst in Koala and Wombat we have seen that the broad ligament is traceable on each side well over to the iliac fossa, in *Macropus* it is a much more limited structure, and does not extend so far, its lateral limitation being ventral, but chiefly mesial, to the psoas minor muscle. Compared with the two above-mentioned Marsupials, there is a lessened laxity of the genitals in *Macropus* associated, no doubt, with the erect attitude assumed by this Marsupial. In a young adult Kangaroo the inguinal fold measured 3 cm. in length with a greatest width near the ovary of 1 cm. There is no peritoneal fold or covering passing from the peritoneum over the ureter to the broad ligament forming a marsupium as in Koala and Wombat. The ovary on each side is readily seen on turning down the upper edge of the broad ligament. The upper edge of the broad ligament extends above the upper level of each uterus and oviduct for .75 cm. to 1 cm., and towards its outer or lateral extremity it forms with the fimbriated portion a hood which more or less surrounds the ovary. From the ovary at its attachment a small fold is seen running on the back of

BROAD LIGAMENT.

the broad ligament to the neighbourhood of the uterus. This represents the ovarian ligament of Man, and it is well defined in Tasmanian devil.

(d) *Tasmanian Devil*.—As in Wombat and Koala, the broad ligament is traced out on each side to the iliac fossa, but is neither so well defined nor does it extend so far laterally, and the inguinal fold is well shown passing from the front of the broad ligament to the inguinal region. The upper extremity of the iliac attachment of the broad ligament (the vascular fold) is not so defined as the lower or inguinal one, and is traced to the lumbar abdominal wall lying on the right side distal to the kidney 5-7 cm.; but on the left side the kidney is placed distal to that of the right, and the fold is traced as far as the lower pole of the kidney. In a well-defined specimen the distance between the extremities of the iliac attachment is 3-4 cm. The triangular fold of peritoneum (part, of course, of the broad ligament) stretching between the two uteri in Marsupials is in the Tasmanian Devil well defined, and curves out dorsal to the uterus on each side as far laterally as the fimbriae, forming a hood behind the upper part of each broad ligament. No fold is traceable from the peritoneum over the ureter to the broad ligament so as to form an ovarian pouch or marsupium. At the upper margin of the broad ligament dorsally the ovary, oviduct, and fimbriae can be seen on eversion, ventral to the psoas muscle, and are not hidden in an ovarian pouch as in Koala. A fold is noted as in *Macropus*, extending from the inner or mesial aspect of the ovary to the broad ligament in the region of the outer extremity of the uterus, with the result that a small pocket is formed about the attachment of the ovary. This fold corresponds to the so-called ovarian ligament of the human ovary, and would appear to be designed to lessen the movement of the ovary, thus avoiding the risk of torsion and also of extra abdominal exodus. Involuntary muscle fibres are present in this fold.

BROAD LIGAMENT.

(e) *Trichosurus*.—The inguinal fold is not so well defined as in Koala, but the lateral attachment of the broad ligament extends well out to the iliac fossa, and is traced proximally into the lumbar region. No pouch lodging the ovary is present as in Wombat and Koala, although a small pocket is noted about the ovary, almost suggesting the remains of the dorsal fold from the peritoneum over the ureter to that of the broad ligament. By slightly turning down the upper free edge of the broad ligament the ovary and fimbriae can be readily seen.

THE FEMALE GENITO-URINARY SYSTEM OF KOALA

(PHASCOLARCTUS CINEREUS).

Ovaries.—These are two in number—one on each side—in relation to the corresponding iliac fossa. Each ovary is somewhat oval and flattened, and has a partial though firm attachment to the broad ligament.

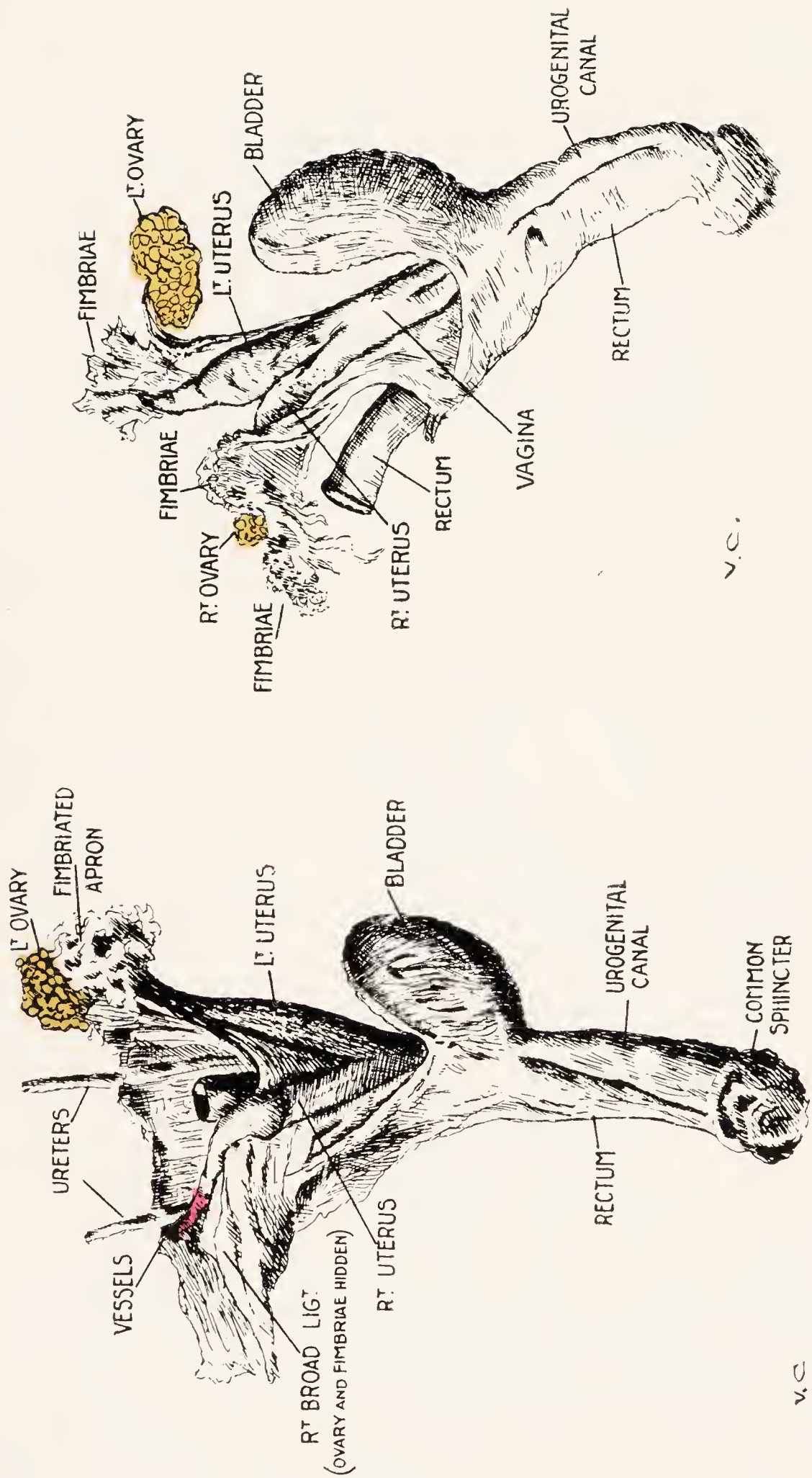
The surface is finely granular or tuberculated owing to the projection of follicles in different stages of development, and measures 1.25 cm. long and .75 cm. in greatest width. The inner, lower, or mesial pole of each ovary is brought into relationship with the peritoneal or outer opening of the oviduct by means of a fine vascular fimbriated apron. This is narrow at its fixed extremity, but gradually widens, and at its free edge the width may be nearly 5 cm. The fimbriated mesentery, like the ovary, lies hidden in the ovarian pocket, from which it must be delivered for examination. The fact that the ovary in Koala is hidden away in a pouch is of no little moment. Is this protective for an organ that would appear, since it may be the subject of cystic disease, to be less vital than that of other Marsupials.

Fallopian Tubes or Oviducts.—These are two in number, viz., a right and left. To examine the oviduct it is best to remove the genitalia from the pelvis, as its dissection is difficult. The minute duct is looped, and its uterine or mesial extremity is plicated for about 1.5 cm. The plications or loops number from 4-6. The length of the non-plicated portion is about 2 cm. long. The average length of the oviduct in an adult is from 3-4.5 cm. The inner or mesial extremity communicates with the outer or lateral extremity of the corresponding uterus. The opening is minute, and best found by opening the uterus and passing a horsehair probe. The termination of the duct is well defined from the uterus, but there is not the marked contrast as seen in Anthropoids and Man.

KOALA.

Uteri.—These are two in number, a right and a left. They are elongate structures, narrowing towards each extremity, quite separate from each other, and each is placed, suspended, between the lateral wall of the true pelvis and the rectum. Connecting the inner margins of each uterus is a triangular peritoneal fold, which passes ventral to the bowel wall. This is 1.5 cm. in its widest part, and 1 cm. deep. In an adult each uterus measures 3.25 cm. long and greatest width 1 cm., and is directed obliquely downwards and inwards. In relation with the lower and inner extremity of the uterus is the upper free margin of the suspensory fold of the bladder containing the vesical vessels—this fold is distinct from that of the genitalia. Dorsal to each uterus, though free from it, is the corresponding ureter. On palpating the uterus, two distinct portions may be defined, viz., an upper thinner, wider, and a lower thicker, more rigid portion. The upper portion represents the incubating part, and its length is 1.75 cm. Its wall is well defined, and the interior vascular and spongy. The lower, dilating, or cervical portion is 1.5 cm. long, and the lining membrane on the interior is paler and rugous owing to the presence of longitudinal folds which end at the vaginal extremity (*os tincae*). This lower distal portion or cervix can be regarded as sphincter, comparable to the pyloric sphincter of the stomach. Like the tubal opening, the vaginal opening of each uterus is minute and admits a horsehair probe.

Vaginal Canals.—The complex vaginal canals are hidden deeply in the pelvis behind the base or distal portion of the bladder, which must be raised to bring them into view. To study them effectively is best done after removal of the genitalia from the pelvis. They are easiest examined from the dorsal aspect. The vaginal canals, together with the terminations of the ureters, are invested by peritoneum so as to form a single piece, and this must be removed in dissections. The vaginae are seen to consist of a median



DISSECTIONS TO SHOW THE FEMALE GENITO-URINARY SYSTEM IN KOALA
(Phascolarctus Cinereus).

KOALA.

thin-walled saccular portion and two lateral narrow (somewhat rigid especially in the distal portion) tubes. The central portion is divided in its interior into a right and left portions by a median septum, which may be complete or incomplete. Thus a right and left median vagina are formed, which usually are non-patent below, *i.e.*, they do not, like the lateral tubes, communicate distally with the urogenital canal. We have seen, however, a communication with the urogenital canal when the septum between the median canals was absent in the lower third, and in another specimen where the septum was almost complete the left larger median vagina communicated with the urogenital canal. Where the septum is complete the left median vaginal canal is the larger and "selected" one usually. The breadth externally of the median portion is 2 cm. above and .5 cm. below, and the length 2 cm. Into the upper portion of each median vaginal canal the vaginal termination of the rigid uterine cervix projects, and this can be best seen by opening the vaginal wall from behind. On the outer wall of each median vaginal canal, about .5 cm. distal to the uterine opening, is the sphincteric opening of the lateral vaginal canal. Though the apparent length of each lateral canal is about 2 cm. in length, it may be traced for a distance of 3-3.5 cm., to terminate finally on each lateral aspect of the urogenital canal about 1 cm. from its commencement. This termination is usually distal to that of the urethra, but all three openings may be proximate. Three portions of the lateral vaginal tube can be made out—an upper relatively thin-walled portion—a middle thick sphincteric portion, which is closely related to the base of the bladder—and a terminal portion, running for about 1 cm. in the lateral wall of the proximal portion of the urogenital canal. The interior of the lower two-thirds of the lateral canal is rugous owing to longitudinal elevations, and the circumference of the canal is about twice the thickness of a knitting

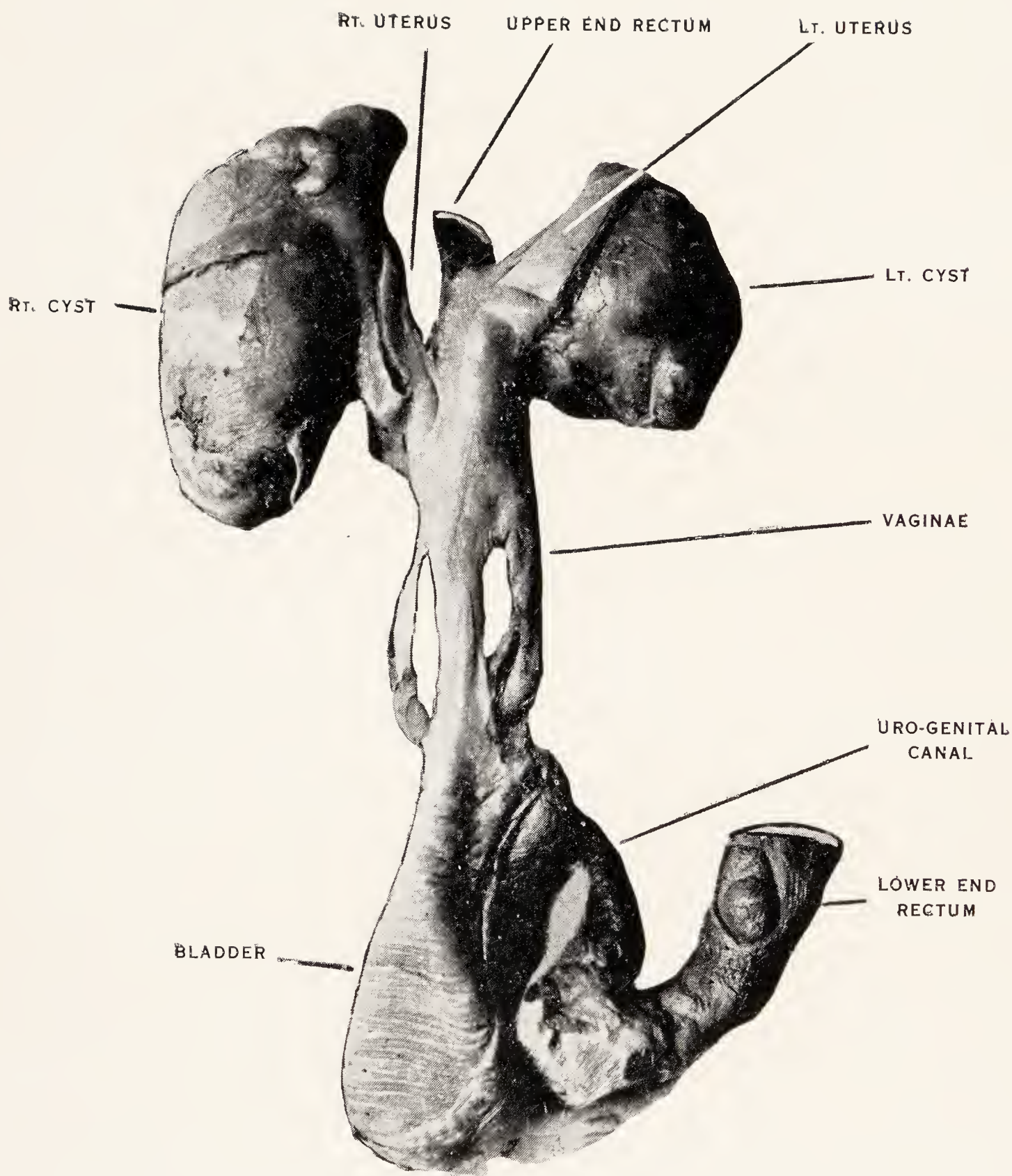


Fig. 7

TUBAL CYSTS IN KOALA (*Phascolarctus Cinereus*).

The Left Cyst is rounded and measures 4 cm. greatest length and 3.3 cm. across. The Right Cyst is flattened, measuring 6 cm. and 3 cm. across. Each Cyst contains gelatinous material, and the wall cells are cubic not columnar. At the lower or distal part of the left Cyst the ovary is seen. Each Uterus is adherent by its dorsal surface and the corresponding Cyst.

KOALA.

needle. The lining membrane of the median vagina is smoother than that of the lateral canals, and a slight elevation of mucous membrane is seen traceable from the uterine termination above, serving to separate off the proximal orifice of the lateral canal. Between the median and lateral vaginal canals the ureters are seen passing to the bladder neck. One cannot help feeling that in Koala, Nature has made a big advance in obliterating the original Müllerian ducts (lateral canals). The median vagina (*caecum*) is well defined, and the lateral vaginal canals appear as appendages of it, though this is not so defined as in *Trichosurus*.

Urogenital Canal.—This measures 4-4.5 cm. long in an adult. Into it the bladder, lateral vaginal canals, and occasionally the median vaginal canal open. It measures .75 cm. across, but is slightly wider proximally than distally. Its interior is moderately rugous owing to the presence of longitudinal folds, and projecting at the ventral aspect of the outlet of the canal is a small flattened vascular and bifid clitoris about .5 cm. long. The cloaca or vestibule into which the rectum and urogenital canal open—the orifices being guarded by sphincters—is small and rarely longer than .75 cm. The common vestibule has its own special sphincter, so that the Koala is really monotrematous. The urethra passes from the urinary bladder, which is well developed, being corrugated externally and rugous internally for about .5 cm., and opens on the ventral wall of the proximal portion of the canal. Laterally, as stated, the lateral vaginal tubes open, and folds are given off from the urinary orifice, terminating at the entrance of the lateral tubes on each side. If the median vagina opens into the urogenital canal, this is medially placed, and lies dorsal to that of the urinary urethra.

In relation with the broad ligament near its lower free edge is a small pedunculated process on each side about the size of a grape seed.

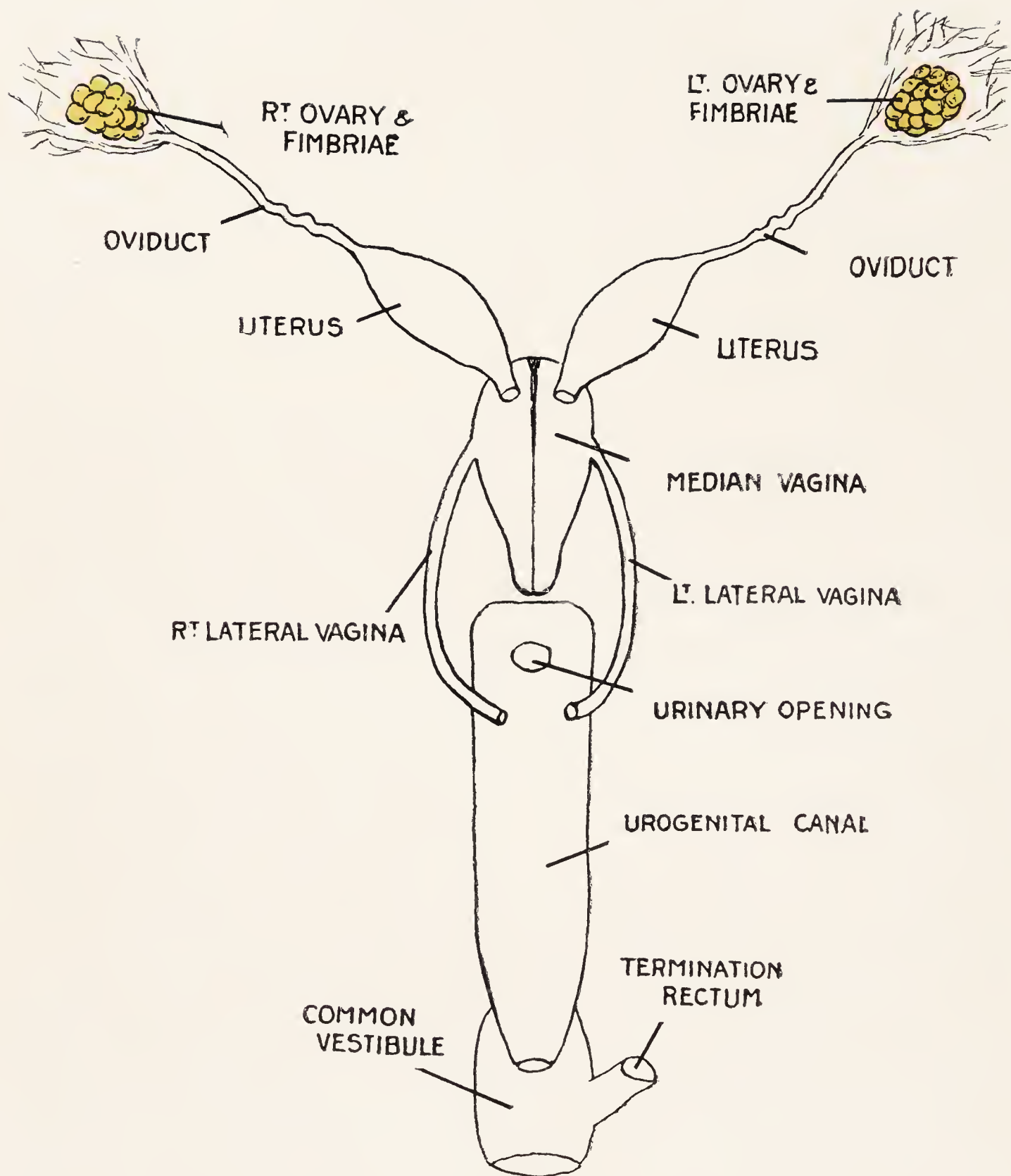


Fig. 8

THE FEMALE GENITO-URINARY SYSTEM IN KOALA
(Phascolarctus Cinereus). Diagrammatic.

THE FEMALE GENITO-URINARY SYSTEM IN WOMBAT

(PHASCOLOMYS).

Ovary.—This is of relatively large size on each side, and measures 2-2.5 cm. in greatest length and 1 cm. in greatest breadth. It has a coarse mulberry appearance, and follicles, especially large ones, are seen in various stages of development. At first appearance the ovary has a distinctly avian appearance, and reminds one of the small type of pathological human cystic ovary. Probably the comparative fixidity of the ovary and its dense smooth covering are necessary to protect such an ovary, with its relatively large ovisacs, from injury. In connection with the ovary, and especially the right, externally a firm distinctive body is noted, which on microscopic section is seen to be enclosed in a well-defined fibrous capsule, and presents the typical structure of a corpus luteum. We have found this body typical and well developed at each extreme of pouch development of the embryo, viz., in one specimen where the embryo had only been placed in the pouch a few hours previously, and in another specimen where the fully developed young Wombat was ready to leave the pouch. There is no record of placental development in the Wombat. In addition, a smaller corpus may be noted.

Oviduct.—These are two in number, one on each side, and extend from the ovary to the uterus. Between the ovary and oviduct, surrounding the rounded outer or abdominal orifice of the latter, is a well-developed spongy vascular fimbriated apron, which when moderately stretched measures 6 cm. across. The oviduct is but slightly tortuous, and measures 7-8 cm. long. It is wider externally, .3 cm., than internally, and just before joining the uterus the width may be less than .25 cm.

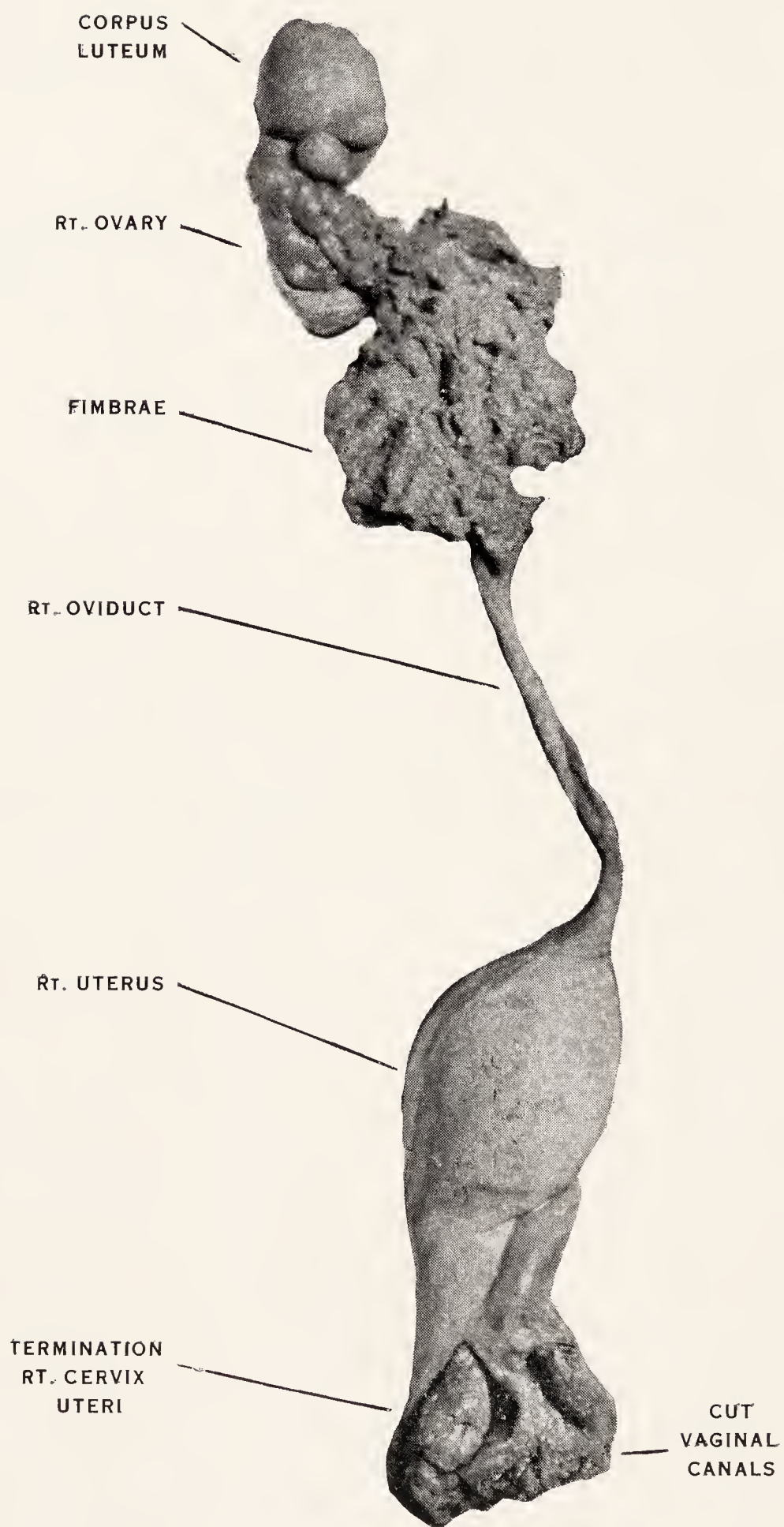


Fig. 9

DISSECTION TO SHOW OVARY AND UTERUS, RIGHT SIDE,
from a Victorian Wombat, with a Young in Pouch.

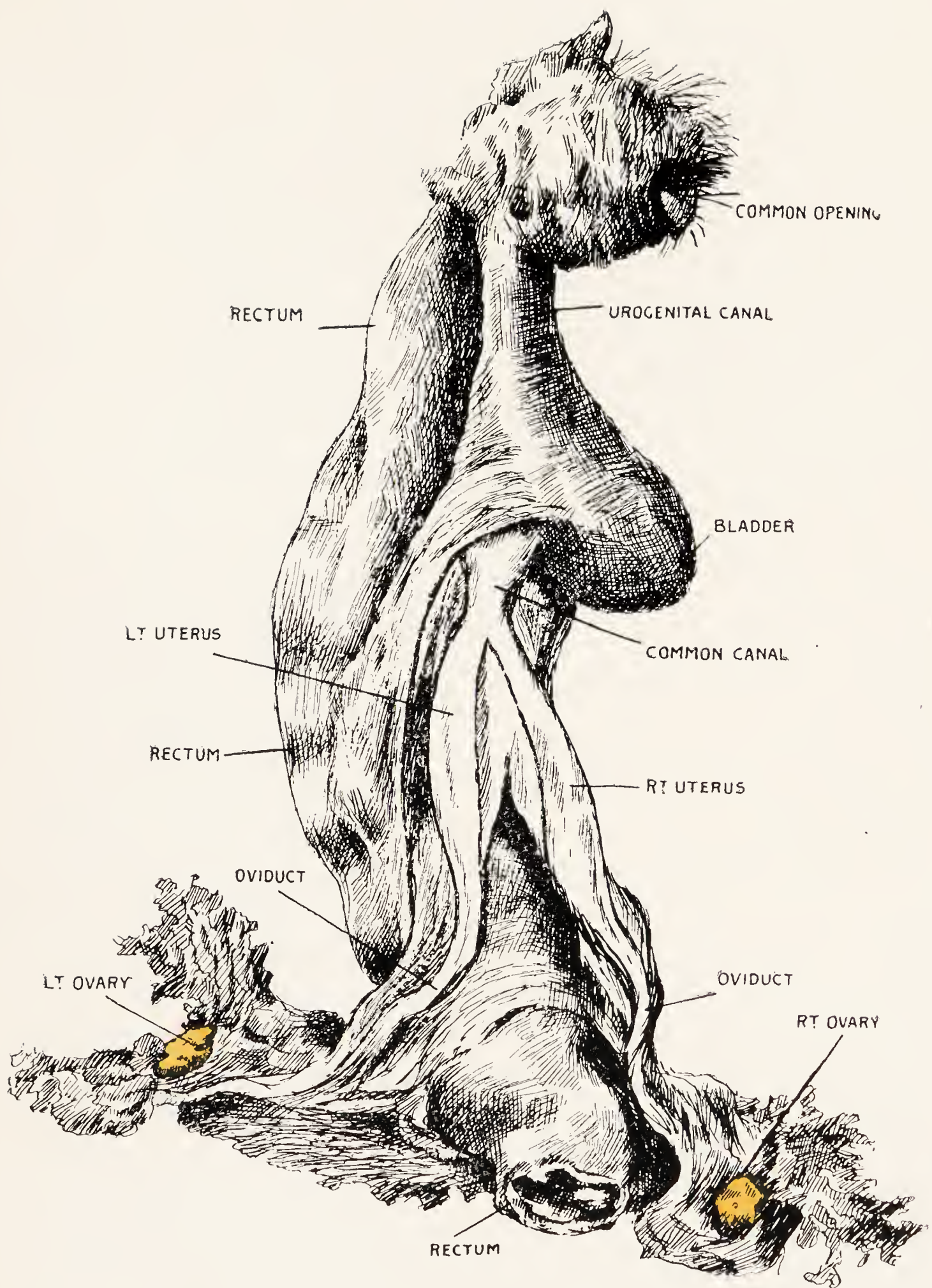


Fig. 10

THE FEMALE GENITAL SYSTEM IN VICTORIAN WOMBAT
(*Phascolomys Mitchelli*).

WOMBAT.

Uteri.—These are two in number, one on each side. They are somewhat oval bodies, measuring in a female, with a young one in the pouch, 6.5 cm. in greatest length and 2.5 cm. in width. The uterus presents for examination a body or incubator and cervix or dilator. This latter measures nearly 3 cm., and is partly external and partly contained in the median vagina. Each uterus and cervix are distinct. On opening either uterus the interior or lining membrane was found markedly lax and vascular, and formed a well-marked bulging on the outside of the uterus, reminding one somewhat of the human placenta. A section of the lining membrane showed a great mass of actively secreting tubular glands.

Vaginal Canals.—These are three in number, a median and two lateral canals. The median canal is the prominent one, measuring 7.5 cm. in length and 1.75 cm. in greatest width. The lateral canals appear as appendages on each side, being very adherent to the median vagina, and if it were not for the ureter passing between the median and lateral canals on each side, separation would be difficult. These lateral canals measure 5 cm. long and .5 cm. across, and open above into the median canal just distal to the uteri, while below they open into the urogenital canal. The interior is pale and shows longitudinal folds. The interior of the median vagina is red, spongy, and vascular, resembling that of the uteri. Into it open proximally the uteri and the lateral vaginal canals, while distally it opens into the urogenital canal dorsal to the bladder, which is not so rugous as in Koala. In the median vagina is a mesial septum well defined proximally, but disappearing distally, which serves to separate the orifices of the uterus and lateral vaginal canal on one side from those of the other. The cervix uteri on each side forms a spongy prominence in the median vagina on which the orifice is found. This prominence measures nearly 2 cm. long and .5 cm. across.



Fig. 11

DISSECTION OF LEFT FEMALE PELVIS, VICTORIAN WOMBAT,
TO SHOW RELATION OF GENITO-URINARY ORGANS IN SITU.

R Rectum. P Peritoneum of Dorsal, Lateral, and Ventral Abdominal Walls, with top of Epipubic Bone (B). C Inf. V. Cava (Dors-Caval Vein). V Median and Lateral Vaginae. D Uro-Genital Canal. A Cloacal Sphincter. E Urinary Bladder. N Left Symphysis Pubis with attachment of Gracilis. T Right and Left Uteri. M Right and Left Broad Ligaments containing Oviducts. The opening on each side leads to the Ovarian Marsupium, containing the Fimbriae and Ovary and mesial to the opening is seen the Ureter. H Site of Fold on Ventral Surface of Broad Ligament (fibro-muscular) passing to Ingurial Region ("round" ligament). S This corresponds to the position of Ovary, Fimbriae, and Pavilion, which are not seen, being hidden in the Ovarian Fossa or Marsupium.

WOMBAT.

Urogenital Canal.—As in the other Marsupials, this opens below into the common vestibule with the rectum, and the orifice of the common vestibule or cloaca is guarded by the common sphincter. Into the urogenital canal proximally open the urinary and vaginal canals as stated. The ureters, as in other Marsupials, open into the base of the bladder, and not into the urogenital canal as in Monotremes. This canal measures 7 cm. long and 1.5 cm. wide. It is pale in contrast to the median vagina and uteri, and its interior is rugous owing to the presence of seven longitudinal folds.

THE FEMALE GENITO-URINARY SYSTEM IN MACROPODIDAE

(KANGAROOS AND WALLABIES).

Ovaries.—These are two in number, one on each side, placed on the dorsum of the broad ligament, and each is readily seen in turning down the upper margin of this structure. Each ovary is smooth, firmly attached for about .5 cm., and the outer portion is firmly embraced by the fimbriated apron. It measures 1-1.5 cm. in greatest length and .75 cm. in greatest width. The fimbriated apron between the outer extremity of the oviduct and the ovary is not so well defined as in Koala, and at its attachment measures about .5 cm.

Oviducts or Fallopian Tubes.—These are two in number, one on each side, situated in the upper lateral part of each broad ligament. Each forms a distinct curve between the fimbriated apron and the uterus. In contrast to *Trichosurus* and Tasmanian devil, they show little tendency to convolution. Each measures 1.5 cm. to 2 cm. in length and 1 mm. across. The transition from oviduct to uterus is more gradual than in Tasmanian devil, though the junction of duct and uterus is well defined.

Uteri.—These are two in number, one on each side. They are elongated bodies, more vertically and less obliquely placed than in Koala or Tasmanian devil, and in the ordinary unimpregnated state an average measurement would be 3-3.5 cm. long and .75 cm. in greatest width. Each uterus is distinct from its fellow, and between each inner aspect as far as the cervix a peritoneal fold is present as in other Marsupials, which is part of the broad ligament. Two distinct portions of the uterus can be recognized, viz., a body or incubating portion 2 cm. long, the interior

KANGAROOS AND WALLABIES.

of which is coarsely rugous, and a narrower cervical or sphincteric portion 1.5 cm. long, the width of which is rarely more than .3 to .5 cm. The interior of the cervical portion presents longitudinal folds traceable to the small cervical opening, which will rarely admit more than a coarse horsehair probe. Each cervix is almost completely contained in the lateral wall of the proximal portion of the median vagina—common canal—forming a decided projection into the interior at its termination.

Vaginal Canals.—These are three in number, a median and two lateral ones, and all are well defined. Into the proximal portion of the median canal each cervix uteri opens, and also each lateral vaginal canal, since on opening the median vagina dorsally by a vertical mesial incision all these can be demonstrated.

The portion of each uterus, as demonstrated in an undissected specimen, is body and commencement of the cervix. This is succeeded by what apparently is a common canal about 1.75 cm. long, from which the two lateral and median vaginae appear to be coming off. This common portion must be regarded as belonging to the median vagina, since, apart from histological examination, we can reach the proximal termination of this common canal by opening the median vagina about its middle and slitting it up longitudinally ; and, furthermore, as stated, the cervix uteri on each side forms a projection on its lateral wall proximally, and may be easily separated from its fellow within the median vagina. The median vagina is mesially placed between the two lateral vaginae lying dorsal to the bladder, with the base of which and the urethra it is in close relation. In an average specimen it measures 6.5 cm. long, with a greatest width of .5-.75 cm. On its floor or dorsal wall some longitudinal striae may be seen, which



Fig. 12

THE FEMALE GENERATIVE SYSTEM IN MACROPODIDÆ
(Kangaroos and Wallabies).

H Lymphatic Gland. F Peritoneum. R Right and Left Ovaries. E Right and Left Fallopian Tubes. T Right and Left Uteri. A "Common" Canal (Portion of Median Vagina). K Ureter. V Mesial and Lateral Vaginal Canals. B Bladder with Ureters. S Commencement of Uro-Genital Canal opened to show openings of Genital and Urinary Canals.

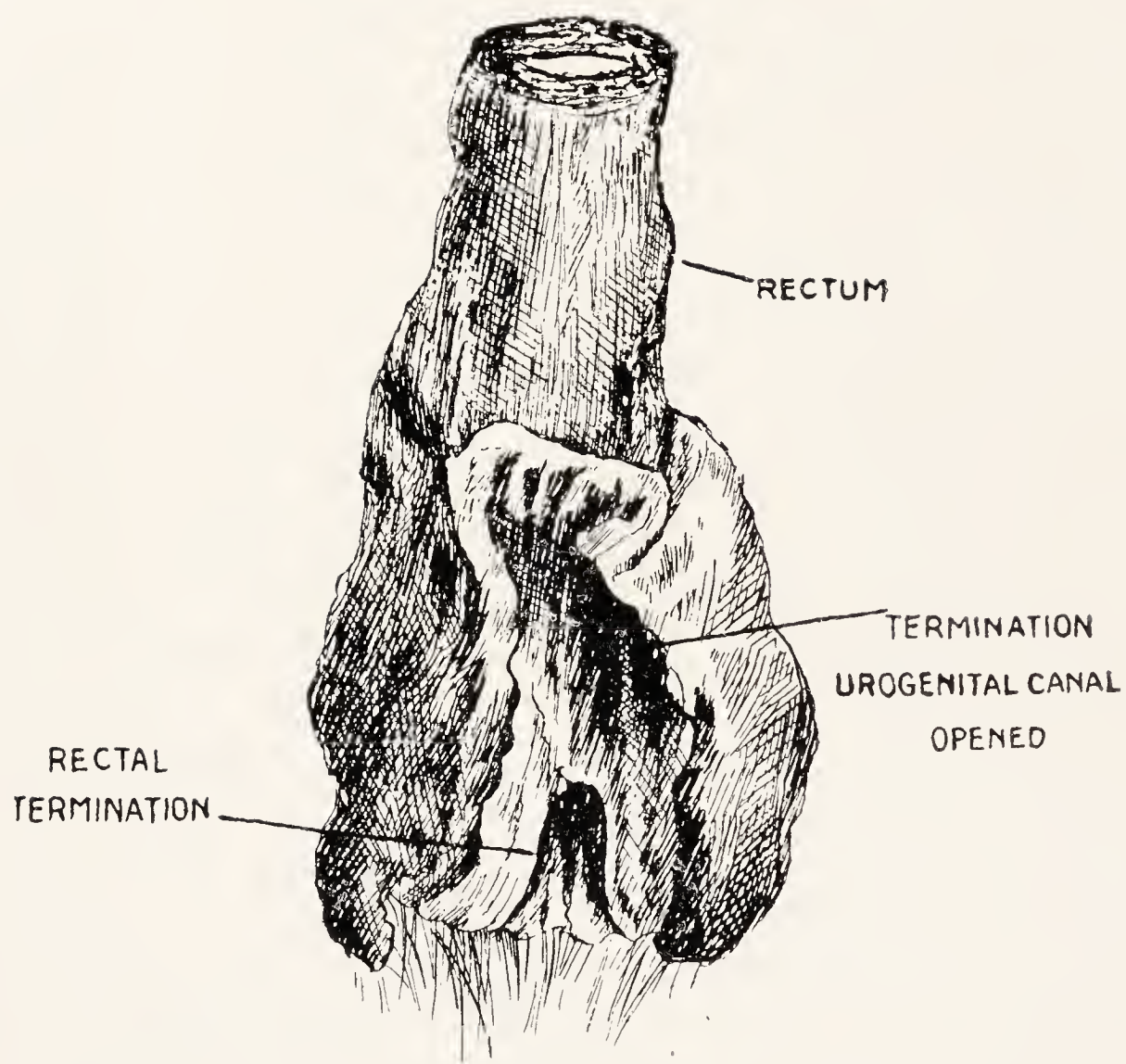


Fig. 13

DISSECTION TO SHOW TERMINATION OF RECTUM AND
UROGENITAL CANAL, FEMALE MACROPUS.

This is the distal portion of specimen shown in Fig. 12.

KANGAROOS AND WALLABIES.

are usually more marked in the proximal portion. The median vagina is connected with each lateral vagina by peritoneum, and in this the ureter may be seen passing to the base of the bladder. An aperture of communication between the distal portion of the median vagina and the urogenital canal is not apparently demonstrable in all varieties of Macropodidae. Richard Owen regarded the communication as normal after parturition. On the question of this communication important papers have been published by the distinguished Australian naturalist, J. J. Fletcher, in the *Transactions of the Linnean Society of N.S.W.*, vols. 6, 7, and 8. The opening between the median vagina and the urogenital canal is usually found in Macropods, but least frequently in *Macropus Major*. Fletcher's own observations showed that it is possible for the direct communication to exist in virgins, while those of other zoologists show that "exceptionally this is actually the case." But more usually, according to Fletcher, it would seem to be formed later in life, probably during pregnancy or at parturition. The lateral vaginal canals are two in number, one on each side. They form a well-marked loop, being directed usually upwards and outwards, and then arching downwards and inwards, to finally terminate at the urogenital canal. Proximally they open into the lateral wall of the commencement of the median vagina. This opening may be placed in juxtaposition to that of the cervix uteri, to which it is somewhat ventral, or it may be placed on the lateral wall .5 cm. distal to the cervix. The opening is guarded by a sphincter. Each lateral vagina varies from 7-9 cm. long and .3-.75 cm. wide, being usually wider below. A ridge may be defined serving to separate off the openings of the lateral canal and cervix of one side from those of the other, but a ridge

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denoting the original separation of the median vagina into two portions is in my opinion not easily definable. Each lateral vagina opens below into the proximal portion of the urogenital canal, after running in the lateral wall for about .75 cm. The arrangement here is as follows:—Mesially and ventrally placed is the orifice of the urethra, while more dorsal but mesial is a small pedunculated elevation corresponding to the orifice of the median vagina, and running down from this on each side is a well-defined ridge. Thus three grooves or channels are formed, a mesial or urinary, and two lateral ones into which open the lateral vaginae, the orifices of which are guarded by sphincters. From the urethral orifice a small ridge runs down also for about 1 cm. The bladder is well developed, though not so rugous as in other marsupials. There is a well-defined urethra with a greatest length of 2 cm., which lies ventral to the terminations of the vaginal canals.

Urogenital Canal.—This is comparatively small, and measures about 3.5 cm. in length and greatest width 1.5-1.75 cm. Into it proximally, as described above, the urinary and genital tracts open. Its interior is roughened, due to the presence of longitudinal folds, and a well-defined clitoris is seen at its distal extremity. A cloaca or common vestibule into which the urogenital canal and bowel open can be hardly said to exist in either Kangaroo or Wallaby. There is a common sphincter, but while the intestine terminates just within the sphincter, the urogenital canal terminates about .75 cm.-1 cm. proximal to the sphincter. From the point of view of an advance towards the higher mammalian type this region in Kangaroo and Wallaby should be studied with that of the Tasmanian devil (*Dasyurus Sarcophilus*).

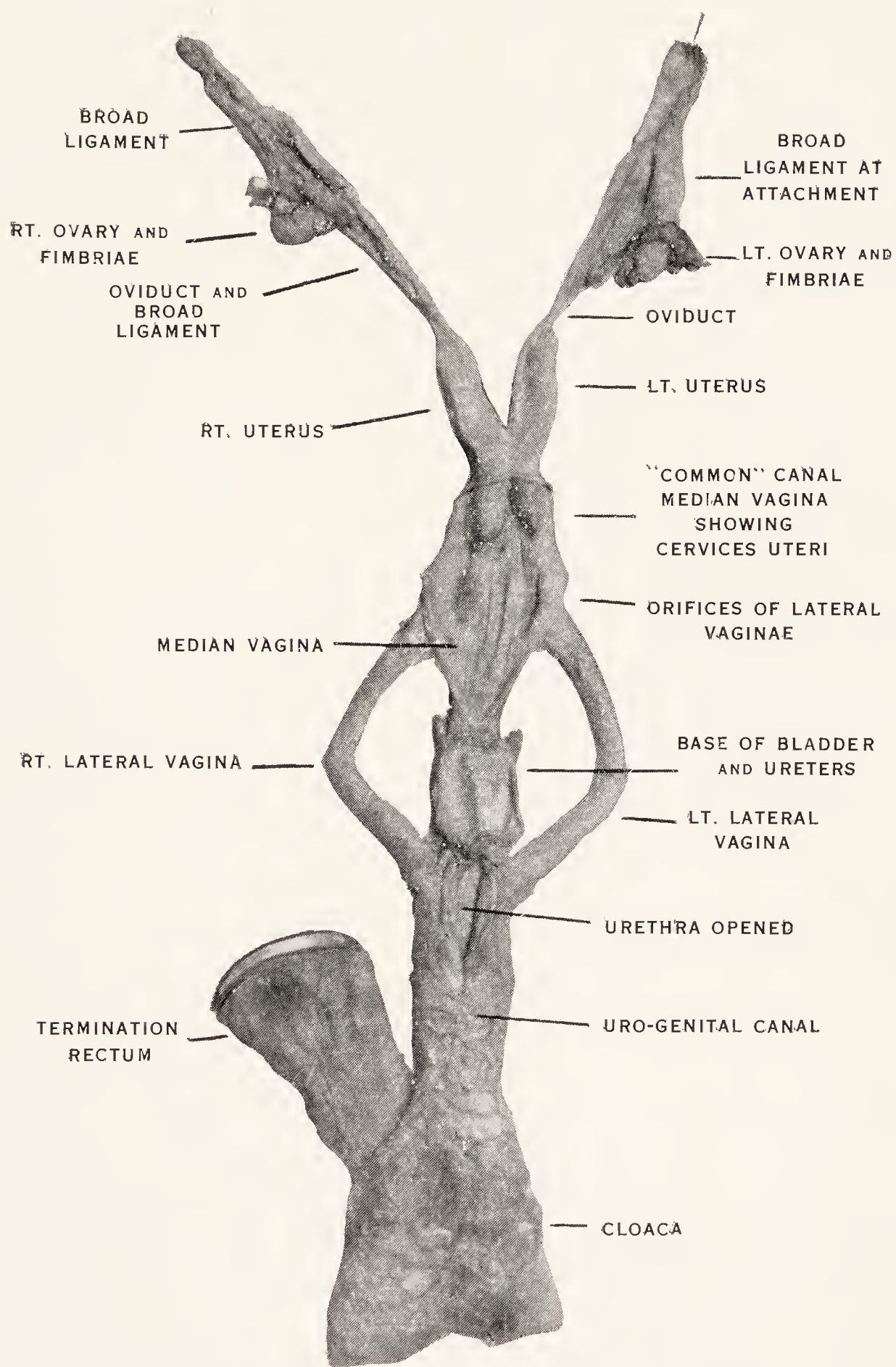


Fig. 14

DISSECTION TO SHOW GENITO-URINARY SYSTEM, FEMALE KANGAROO (*Macropodidæ*). Opened from behind.

Into the Median Vagina are seen opening the two Uteri and the two Lateral Vaginae.

THE FEMALE GENITO-URINARY SYSTEM IN AUSTRALIAN PHALANGER

(TRICHOSURUS).

Ovaries.—These are two in number, one on each side. The ovary is found in a small pocket dorsal to the upper part of the broad ligament near its iliac attachment. As in the case of Koala, the ovary is finely irregularly nodulated. It measures 1 cm. long and .5 cm. in greatest width. Its attachment to the dorsum of the broad ligament is narrow, and measures only .5 cm. The fimbriated apron or fringe, which is really a highly specialized portion of the outer part of the upper edge of the broad ligament, is traced between the attached part of the ovary and the abdominal termination of the oviduct. Its greatest length is about 1 cm. and breadth about .5 cm., and it may be traced along the upper margin of the broad ligament internal to the end of the oviduct.

Oviducts or Fallopian Tubes.—These are two in number, one on each side. Each duct is minute and convoluted, and careful dissection is necessary to expose it. It is best demonstrated by holding a specimen up to the light and separating ovary, fimbriae, and outer end of the uterus. In its normal convoluted state it extends for about 1-1.5 cm. between the fimbriae and the outer end of the uterus. By means of the fimbriated apron it is brought into relation with the ovary. When straightened, each oviduct measures 2-2.5 cm. in length. There is not a sharp line of demarcation between the oviduct and the outer or lateral extremity of the uterus.

Uteri.—These are two in number, one on each side. Each is an elongate structure, narrowing at the extremities and directed downwards and inwards ventral to the brim of the pelvis. Each measures about 2.5 cm. in length, and

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the greatest width in a non-pregnant adult is about .5 cm. As in the Koala, an incubating and dilating or cervical portion are noted, but the latter is relatively smaller than in the case of Koala. The incubating portion has a comparatively smooth inner surface, and measures 1.75 cm. long. The cervical portion is about .75 cm. long. Its greatest external width is .25 cm. It feels firm, and the interior is rugous owing to the presence of longitudinal folds. It really represents the uterine sphincter, and projects for about .25 cm. into the interior of the uterine vagina. On the tip of the projection a fine opening is noted, which admits a horsehair probe. Occasionally in the Phalanger one meets with a uterine tube of narrow and uniform calibre.

Vaginal Canals.—From the point of view of size the median vaginal canal which is present would appear to be the most important part of the genitalia. Indeed, at first examination its appearance—since the lateral vaginal canals are only brought into view by careful dissection—resembles somewhat the human and anthropoid uterus, with the true uterine tubes corresponding to the oviducts. The vaginal canals are three in number—a median and two lateral ones—and the latter from their size appear as appendages of the former. Into the median vagina proximally the cervix uteri of each side opens, and laterally at a distance of about .5 cm. from the cervical opening on each side the proximal opening of the lateral vaginal canal is defined. The interior of the median vaginal canal is finely rugous, and on the dorsal wall a faint streak scarcely deserving the name of elevation is seen, suggesting a division into two portions. Its length is about 3 cm. and greatest breadth about 1.25 cm. Usually we have found a small pinhole opening leading from the median vagina to the urogenital canal. In other cases there may only be a fine membrane between the two, so that in the passage of

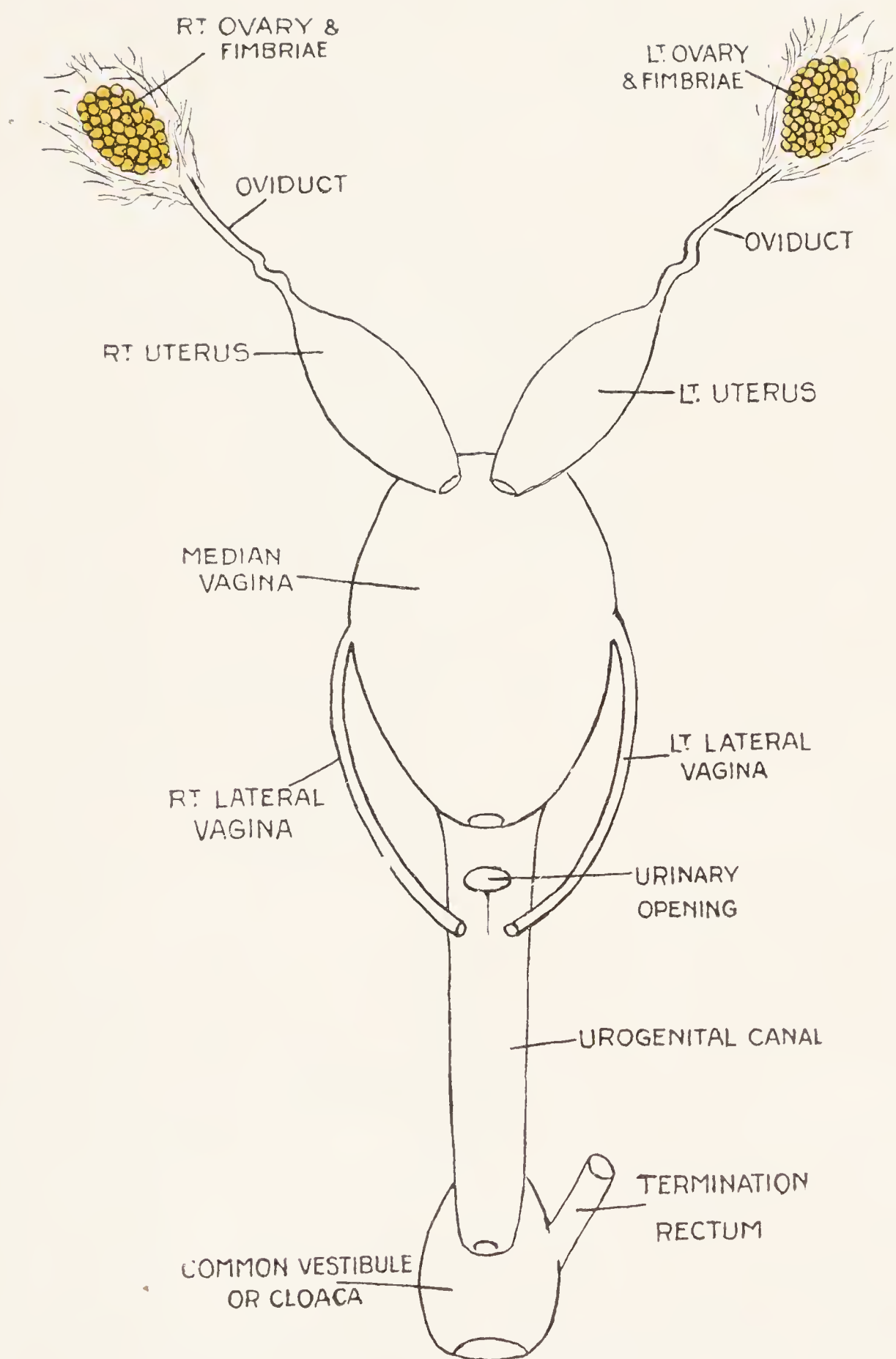


Fig. 15

THE GENITO-URINARY SYSTEM IN AUSTRALIAN PHALANGER.
(Trichosurus). Diagrammatic.

AUSTRALIAN PHALANGER.

the embryo there is little to rupture. Each lateral vaginal canal is narrow and rigid, with a width of .25 cm., and measures 2-2.25 cm. in length. Each is traced in the lateral wall of the commencement of the urogenital canal for about .5 cm., finally opening into the canal dorsal to the urinary opening. Dorsal to the urethral opening in the urogenital canal is a distinct pouch formed by the presence of a fold on each side from the termination of the urethra to the sides of the commencement of the urogenital canal. Dorsally also, in addition, a narrow ridge is noted, on each side of the commencement of which is the opening of the lateral vaginal canal. At the top of the ridge, *i.e.*, more mesial and proximal than the openings of the lateral canals, is the opening of the median vaginal canal. As in the other Marsupials, the ureters pass between the lateral and median vaginal canals on their way to the neck of the bladder. This resembles that of Koala, being corrugated externally, thick walled, and markedly rugous internally. The urethra measures about .5 cm. long, and opens into the commencement of the urogenital canal.

Urogenital Canal.—This is an elongate structure, which in an adult may reach 4.5 cm. long, and opens below, like the rectum, into the cloaca or vestibule. Proximally, as stated, the urinary and genital canals open into it, and its interior is rugous owing to the presence of longitudinal folds. It is wider at each extremity, especially distally, than in the middle, and here the width is about .5 cm. The cloaca or vestibule measures about 1.75 cm. long, and into it both the genito-urinary and intestinal tracts open; but the urogenital opening is more distal than the intestinal, and just within the cloacal (external) sphincter. On examining the interior of the termination of the urogenital canal a bifid clitoris is seen. In relation with the cloacal region two pairs of sebaceous glands are noted.

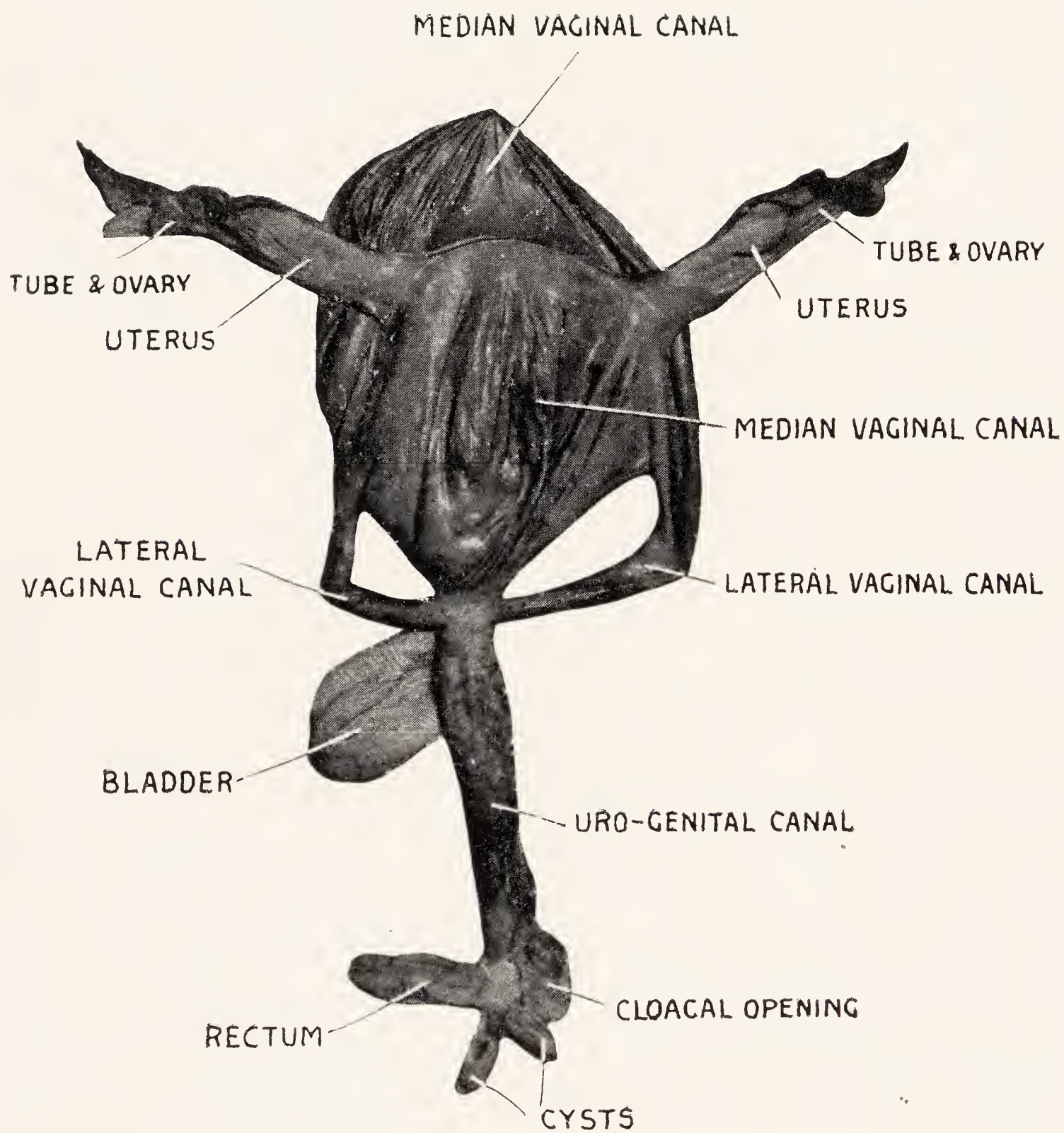


Fig. 16

THE GENITO-URINARY SYSTEM FROM AN AUSTRALIAN PHALANGER
(Trichosurus).

THE FEMALE GENITO-URINARY SYSTEM IN TASMANIAN DEVIL

(DASYURUS SARCOPHILUS).

A distinguishing feature of the genito-urinary system of the Tasmanian devil is the presence of an extensive fatty mesentery, the greatest length or free edge of which may equal 16 cm. and width 14 cm. This apron we have found more fatty in winter than in summer. It is attached along the sides of the true pelvis and behind the pyramidalis muscle, between the pubic bones, completely screening the bladder from view ventrally. In the true pelvis an extension is described along the urogenital canal for more than half its extent, and the broad ligament is continuous below with the fatty apron. Furthermore, the genital tract of the Tasmanian devil is characterized by a decided development towards the higher mammalian type, both at the proximal and distal extremities, and it is important to note that Dr. Margaret McLorinan has described a branch of the left vagus as passing directly into the broad ligament.⁽¹⁾

Ovaries.—These are two in number, one on each side, elliptical, smooth or finely granular, placed at the upper part dorsally of each broad ligament about 1.5 cm. from the iliac “attachment.” Each measures 1-1.5 cm. long and .5 cm. in greatest breadth, though we have seen an adult ovary only .75 cm. long and .3 cm. in breadth. Its attached area to the dorsum of the broad ligament is limited, and only .3 cm. long. The fimbriated apron is not so relatively developed as in *Trichosurus* and *Koala*, and its length of attachment, *i.e.*, between the ovary at its attachment and the oviduct, is about 1 cm.

(1) “Studies on Cases of Uterine Abnormality.”—*Aust. Med. Jour.*, July 5 h, 1919.

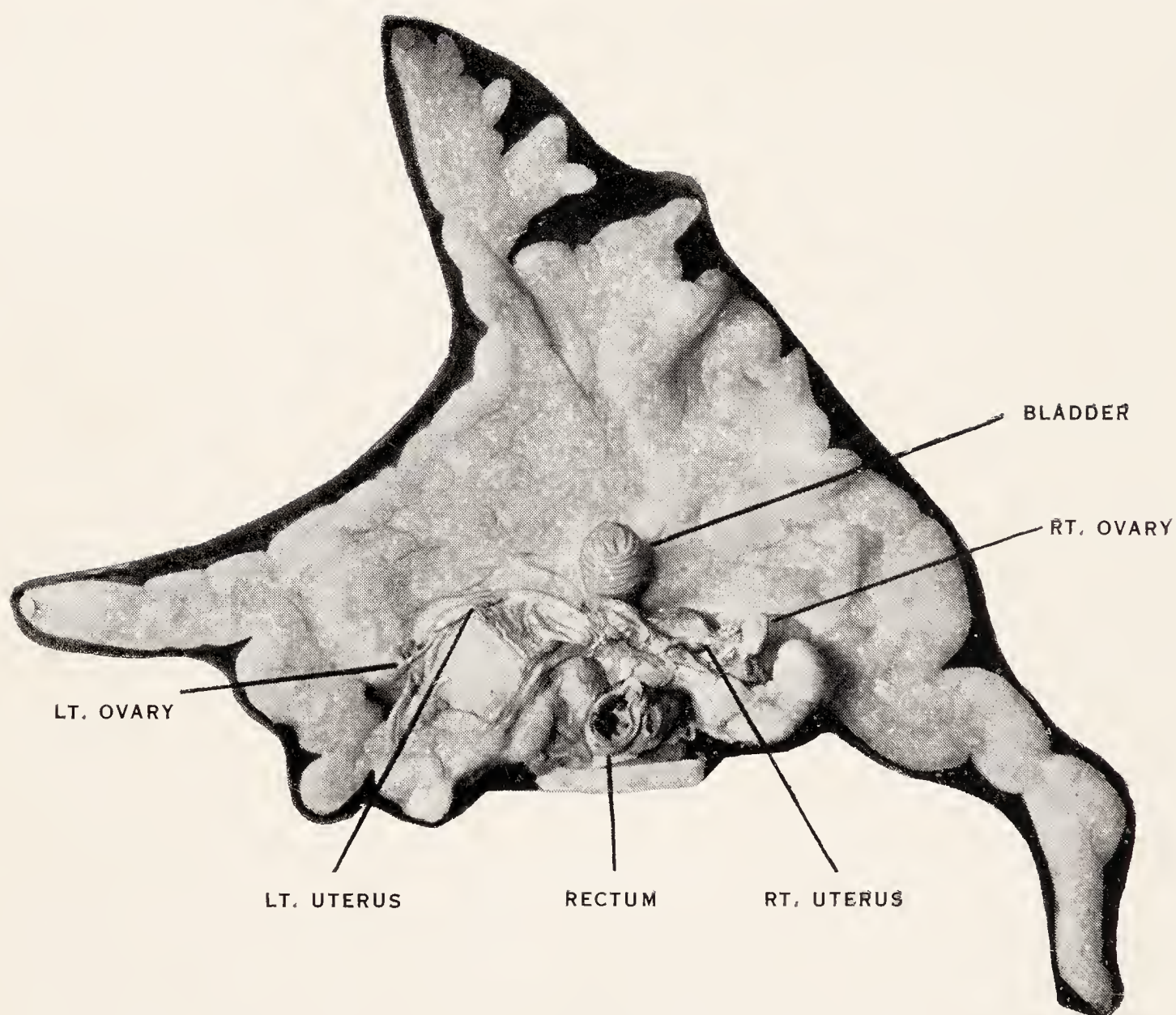
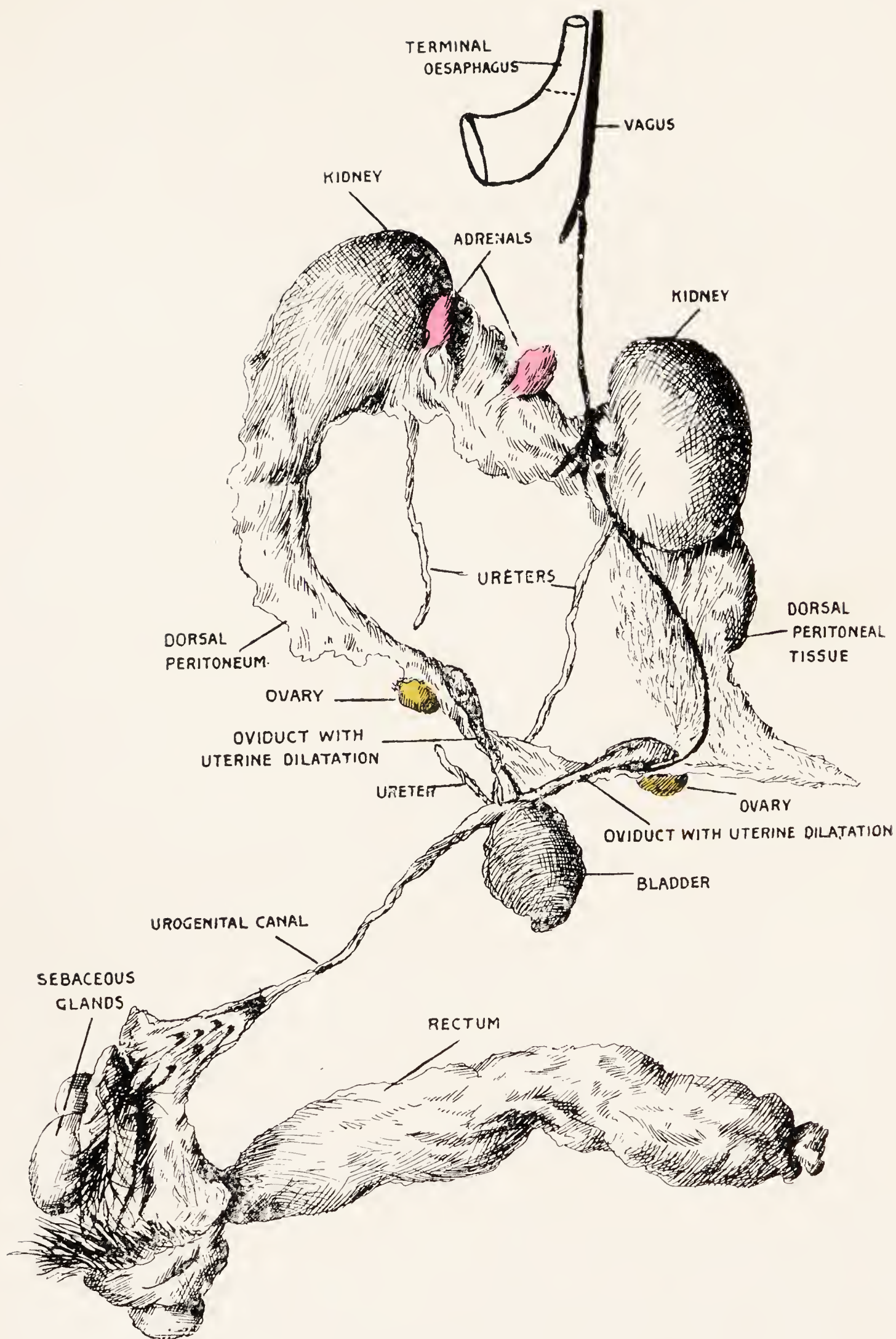


Fig. 17

GENITO-URINARY FATTY MESENTERY IN TASMANIAN DEVIL
(*Dasyurus Sarcophilus*).



V.C Fig. 18

THE FEMALE GENITO-URINARY SYSTEM IN TASMANIAN DEVIL
(*Dasyurus Sarcophilus*).

TASMANIAN DEVIL.

Oviducts or Fallopian Tubes.—These are two in number, one on each side. Each is continuous with the uterus mesially, and laterally is connected to the ovary by the fimbriated apron. The tube is finely convoluted—more so than in Koala and Trichosurus—and is scarcely larger in lumen than a linen thread. Careful dissection is necessary to expose it, and unconvoluted it measures 1.5 to 2 cm. in length. The inner termination at the uterus is abrupt, as in the case of the human genitalia.

Uteri.—These are two in number, one on each side. As previously stated, there is great laxity of peritoneum between the two uteri, and although in Koala and Trichosurus the upper margins of the uteri practically correspond to the upper margin of the broad ligament, here the peritoneum is at least .75 cm. above them, so that they appear as projections on the ventral face of the broad ligament. In other Marsupials, *e.g.*, Koala and Trichosurus, we designate as uterus the canal extending between the inner extremity of the oviduct and the complex vaginal canals. But this description does not hold in Tasmanian devil. The vaginal canals proper are comparatively minute (covering an apparent area of about .75 cm. long), and are deeply hidden in the pelvis behind the neck of the bladder. Between the inner extremity of each Fallopian tube and the vaginae is a canal on each side 4.5 cm. long. The proximal part of this canal is uterus proper. It is more rounded and less oval than in Koala and Trichosurus, and varies from 1.5 cm. in length and .5 cm. broad to 2.5 cm. long and 1.5 cm. in greatest breadth when examined in the breeding season without pregnancy. The wall of the latter size was .25 cm. thick, and the interior was markedly rugous. The distance between the inner or lower ends of each uterus is about 2 cm. The distal part of the canal

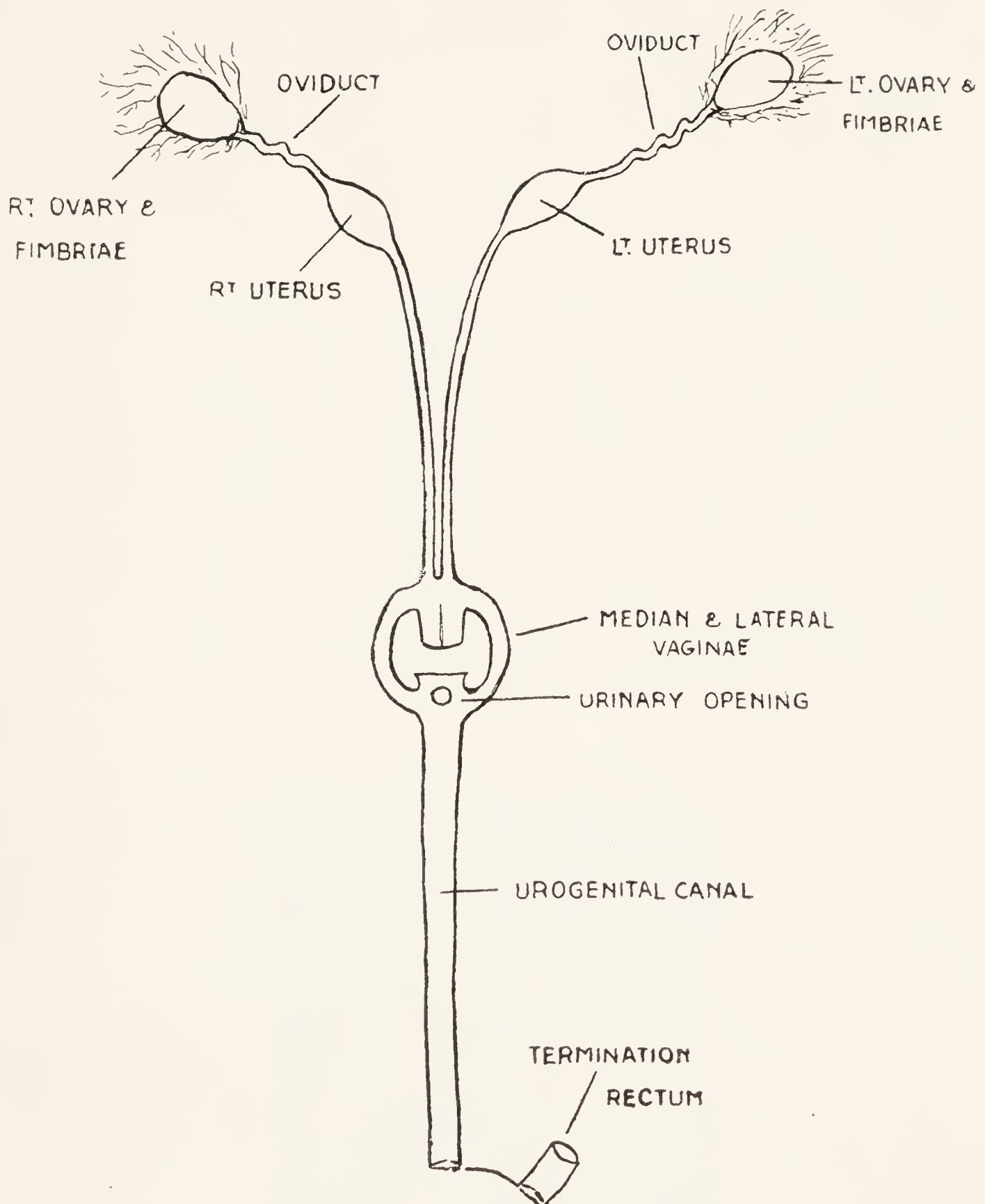


Fig. 19

THE GENITO-URINARY SYSTEM IN TASMANIAN DEVIL
(*Dasyurus Sarcophilus*). Diagrammatic.

TASMANIAN DEVIL.

between vaginae and oviduct on each side is a narrow duct about 3 cm. long and .25 cm. across. This we regard rather as vaginal than cervix uteri. Each can be separated from its fellow right down to the vaginae proper, though they are closely adherent in the lower third, and on the interior fine longitudinal striae are marked, especially at the uterine junction.

Vaginal Canals.—The vaginae proper are, compared with other Marsupials, extremely small and deeply placed in the pelvis dorsal to the neck of the bladder. Careful dissection is necessary for their examination, and only after removal of the genitalia from the body. A median vagina and two lateral vagina can be recognized, and the apparent length of each is about .5 cm. The lateral vaginae are, however, traced in the lateral wall of the urogenital canal for about .5 cm., and each finally opens into the latter on the side of a longitudinal ridge lateral and dorsal to the urinary opening, frequently forming a distinct projection. In spite of its small size, the median vagina would appear to be subject to variation. It may be only .25 cm. long, and be divided into two equal portions by a median septum. The septum may separate two unequal portions—a small right .25 cm. long and a longer left portion .5 cm. The length may be .5 cm., and be divided by the median septum into two portions, or the septum may be absent. Each median vagina communicates with the lateral vagina and “uterine” canal of the same side, but we have never found any communication with the urogenital canal.

Urogenital Canal.—This is an elongate tube into which proximally the bladder and the vaginal canals open. As in the case of Koala, the bladder, though small, is corrugated externally, and markedly rugous within. The canal is about 8-10 cm. long, and the width varies from .25 cm. to

TASMANIAN DEVIL.

.5 cm. At its distal extremity a well-defined clitoris is noted. This latter is tongue-shaped, .5 cm. long and .25 cm. in width, showing a median ridge and a depression on each side. An interesting feature about the reproductive organs of the Tasmanian Devil is the development of the external genitalia towards a higher mammalian type, *i.e.*, the separation of the urino-genital from the intestinal tract. In other Marsupials, *e.g.*, Koala and *Trichosurus*, both these tracts open into a common vestibule or cloaca guarded by a common sphincter, so that these are truly monotrematous. In *Trichosurus*, however, the genito-urinary outlet is nearer the surface than the intestinal. In the Tasmanian Devil no cloaca can be said to exist. Ventral to, and distinct from, the intestinal orifice, and seen from the surface, is a labial projection corresponding to the termination of the urogenital canal. At the termination two pairs of sebaceous glands are noted, as in other Marsupials.

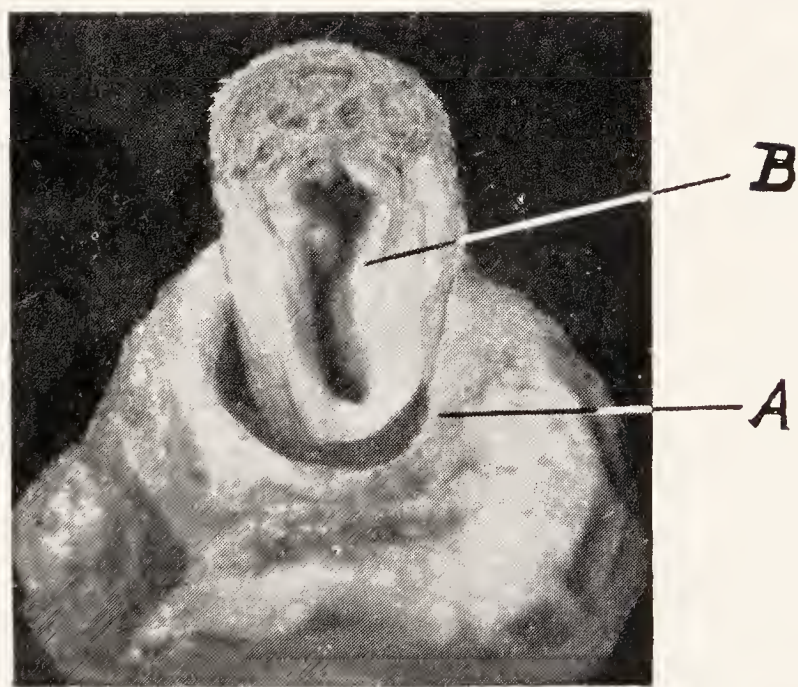


Fig. 20

(A) Rectal, and (B) Genito-Urinary (Vulval) Termination in Female Tasmanian Devil (*Dasyurus Sarcophilus*).

THE MALE GENITO-URINARY SYSTEM IN MONOTREMATA. PLATYPUS AND ECHIDNA.

(a) PLATYPUS.

Broad Ligament.—In both the Monotremes (Echidna, Platypus) the testes are intra-abdominal, and one is struck with the great similarity between the genital system of both the male and the female. As in the case of the ovaries, the testes on each side are suspended freely on a mesentery, which is traced from the ilio-lumbar region along the vas deferens into the true pelvis as far as the commencement of the urogenital canal; so that testis, epididymis, and vas can be lifted freely from the dorsal wall. Great mobility is characteristic of these structures. The upper or lateral attachment of the mesentery or broad ligament on each side is in the ilio-lumbar region about the distal extremity of the kidney, and, as in the female, this attachment is limited by two free margins, an inner or vascular and a thinner outer or fibrous one. The line of attachment between these two margins passes ventral to the lower ribs and measures 2.5-3 cm. long. The attachment of the broad ligament, the greatest width of which may be 4-4.5 cm., is traced obliquely inwards ventral to the psoas minor to the brim of the true pelvis, on the inner aspect of which it ends.

Testes and Effluent Ducts.—The testes are two in number, one on each side, lying freely mobile in the lumbar region ventral to the lower pole of the kidney and the lower ribs. In a well-developed male the length was 4-4.5 cm., and the greatest width 2.5 cm. There is no internal abdominal ring as in the Marsupial. Each testis is enclosed in a strong fibrous tunic, and the upper surface of the testis forms part of the upper boundary of the broad

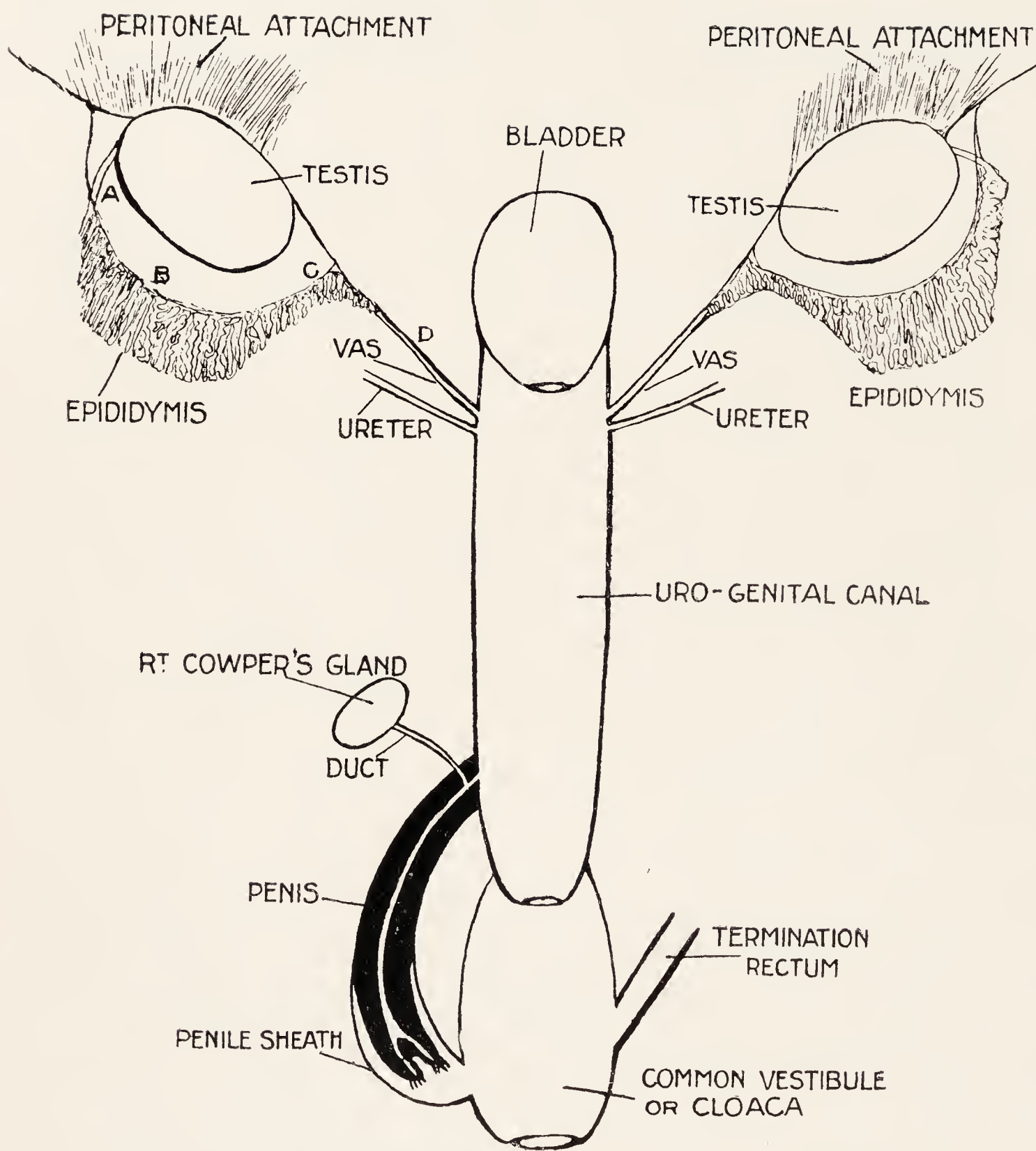


Fig. 21

THE MALE GENITO-URINARY SYSTEM IN MONOTREMES
(Diagrammatic from Platypus).



Fig. 22

TESTIS AND EPIDIDYMIS IN PLATYPUS
(Ornithorhynchus Anatinus).

PLATYPUS AND ECHIDNA.

ligament. There is no inequality in size between the right and the left testis. The vasa deferentia or efferent ducts of the testis are two in number, one on each side, and extend from the upper or outer pole of the testis to the urogenital canal. Each vas is markedly convoluted and lies for the greater part distal and dorsal to the testis so as to form a projection on the front of the broad ligament. This projection may be regarded as epididymis, and its method of suspension is somewhat similar to that of the Fallopian tube in the female. Extending from the upper pole of the testis is the fibrous band limiting externally the upper attachment of the broad ligament, whilst from the lower pole of the testis the upper edge of the broad ligament, also fibrous, is continued on to the vas, the distal or terminal 3 cm. of which form like the testis part of the upper boundary of the broad ligament. The anterior face of the main mass of plications or convolutions, *i.e.*, epididymis, is connected with the testicular bands or ligaments, and so this structure is swung similarly to the Fallopian tube. Between the epididymis and testis there is about 2 cm. of broad ligament. Unfolded, the length of the vas from the upper pole of the testis to the urogenital canal is 9-10 cm. Passing from the testis to the urogenital canal, the following parts (Fig. 21) of the vas may be distinguished. Firstly a straight portion (*a*) 2 cm. in length. Then a convoluted mass, the epididymis (*b*), swung as stated on the broad ligament by two fibrous processes, of which the outer is the longer and measures 4 cm. The length of the epididymis is 4 cm., and the mesial portion is wider than the extremities, and may be 2 cm. across. This is followed by a gradually narrowing portion (*c*), whose greatest width is .75 cm., and is convoluted for about 2 cm., forming, as stated, part of the upper boundary of the broad ligament. The vas finally terminates (*d*) as an apparently straight tube in the urogenital canal, and the width may be only 2 mm.

PLATYPUS AND ECHIDNA.

STRUCTURE OF EFFERENT DUCT SYSTEM.

(a) *Proximal portion, i.e., close to testes.*—Here the section presents the general characteristics of the epididymis on each side. Numerous tubes lined by columnar ciliated epithelium are seen surrounded by areolar connective tissue. A well-defined artery and vein are also seen.

(b) *Prominence or Epididymis.*—This is simply an exaggeration of the preceding section. A small amount of involuntary muscle is seen encircling the tubes, but not so much as in the human type.

(c) *Convolutd portion distal to Epididymis.*—Here the structure is similar. The tubes, however, are fewer but larger, with well-defined lumina.

(d) *Straight Terminal Portion.*—About six tubes are seen in this section. These are arranged in two bundles—three tubes in each bundle—and each bundle is invested with fibrous tissue. The lining of the tubes is columnar stratified epithelium, which is ciliated. The ductus deferens would appear to terminate in the urogenital canal by more than one opening, and in relation to the termination are numerous mucous glands.

Urogenital Canal.—This lies dorsal to the symphysis, and shows proximally the opening of the bladder and the orifice of the renal and genital ducts, and communicates below with the cloaca or common vestibule by a narrow opening. It measures 5 cm. long, and its width above is 1 cm., and below .5 cm.-.75 cm. The wall of the proximal 1 cm. is thicker than the rest, and here open the vas, bladder, and ureter. There is a small pocket distal to the bladder opening, and the vas and ureter open on the lateral aspect of this. There is no promontory or projection as seen in the female.

PLATYPUS AND ECHIDNA.

The vestibule, cloaca, or common terminal canal is 3-5 cm. long, and into it the urogenital and intestinal canals open, the latter being dorsal to the former. Each is guarded by a sphincter. At the termination of the vestibule is a common sphincter, and just within this on the ventral aspect is the opening for the penis, and to this is attached the termination of the preputial covering in which the glans penis is enclosed. This preputial sheath is 3 cm. long in an adult specimen, and proximally is attached to the body of the penis.

Penis.—On the ventral wall of the urogenital canal about 1 cm. from its termination in the vestibule is the pinhole opening of the penile urethra. The penis, which forms an elongated prominence ventral to the termination of the urogenital canal and vestibule, presents for examination a vascular and fibrous body terminating in a glans. The total length is about 4.5 cm., and that of glans 2 cm. The width of the body is .75 cm., and that of the glans penis 1.25 cm. The penile urethra joins the urogenital canal at almost a right angle. This first or vertical position is about .75 cm.-1 cm. long. The glans penis is enclosed, as stated, in a fibrous sheath, and its surface is roughened owing to the presence of firm spinous projections. At its termination a dorso-ventral groove separates the glans into two lobes, a larger and smaller. Each lobe presents a depression which conceals four papillae. The urethral canal divides about the middle of the glans penis into two channels, one for each lobe, and each channel in turn into four divisions, one for each papilla. The function of the penile urethra is seen to be primarily for the conveyance of semen and not of urine, and the structure of the penis represents a decided advance from the reptilian towards the higher mammalian type. As the opening of the penile urethra into the urogenital canal is very minute, and as the penis has to be extruded firstly into the vestibule, and from that through the external sphincter, it is obvious

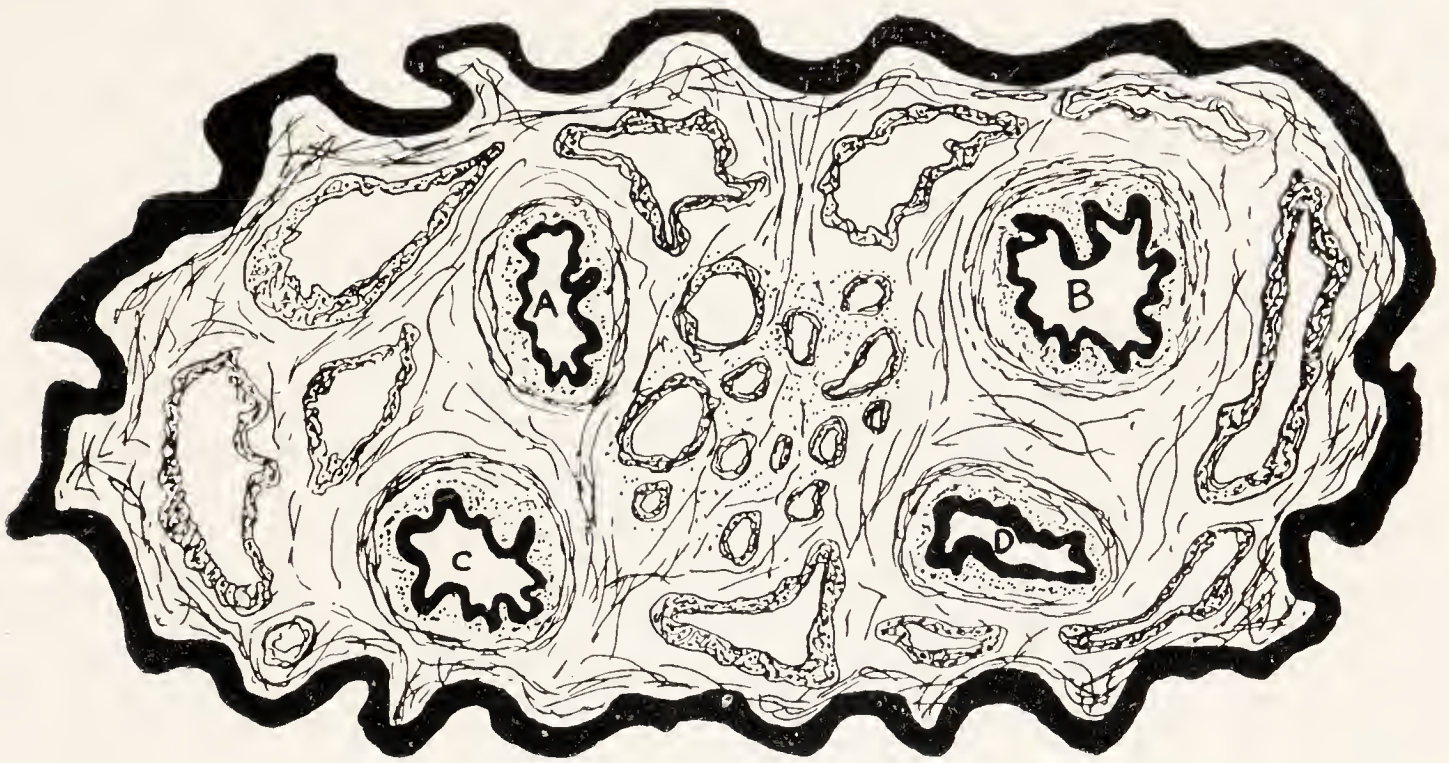


Fig. 23

SECTION THROUGH THE GLANS PENIS. PLATYPUS.
(Ornithorhynchus Anatinus).
A, B, C, D Urethral Channels.

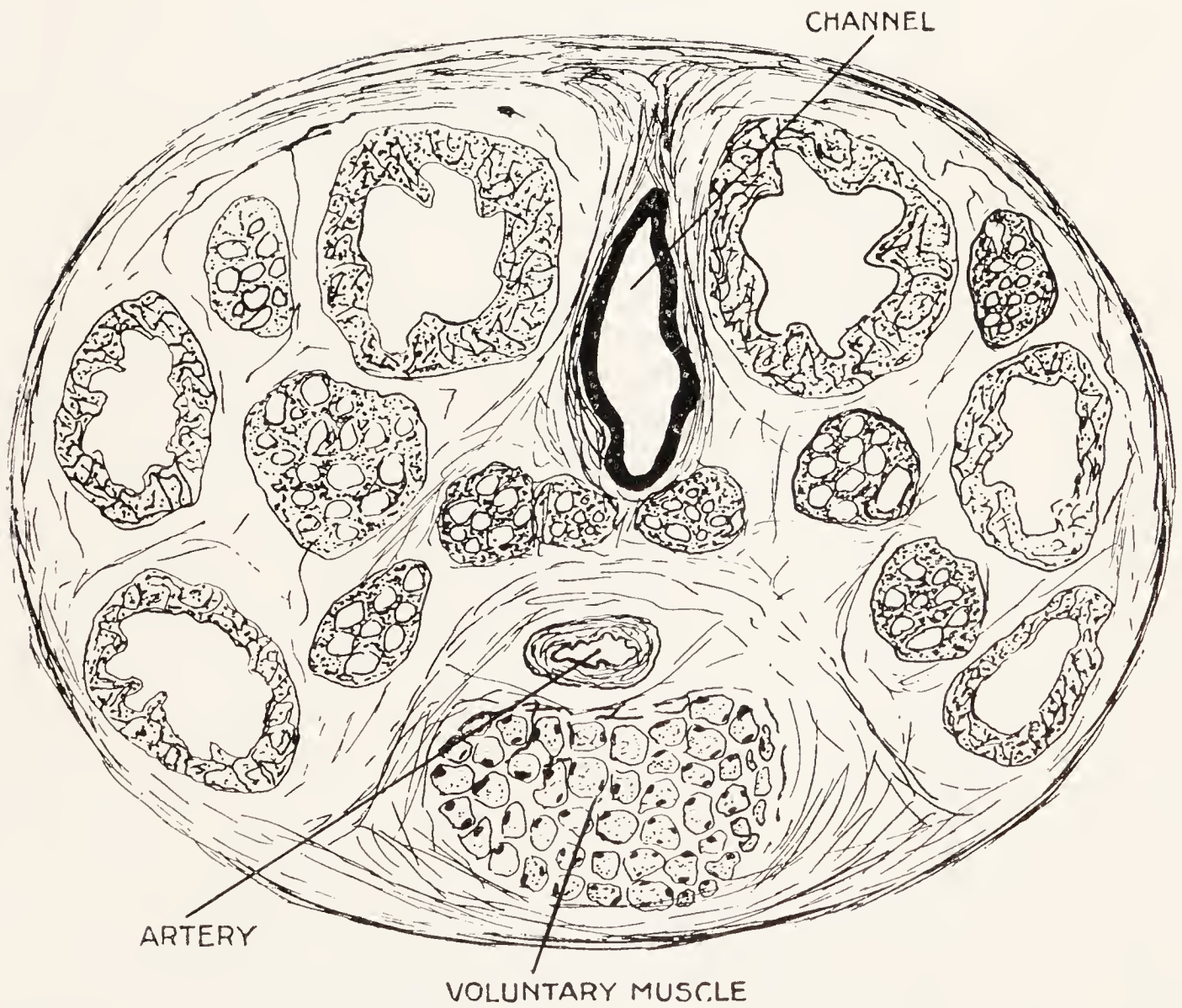


Fig. 23a

SECTION THROUGH THE BODY OF THE PENIS. PLATYPUS.
(Ornithorhynchus Anatinus).

PLATYPUS AND ECHIDNA.

that some special muscular mechanism is necessary for coitus, and more especially to approximate this opening to that of the vasa deferentia, so that not only does the semen escape contamination with the urine, but is prevented from escaping into the cloaca along the urogenital canal. For a dissection of the penis and vestibule, together with the termination of the rectum and termination of the urogenital canal, it is not necessary to divide the pubic symphysis. These structures lie distal to it. A mesial incision is best from the pubic symphysis to the external sphincter of the cloaca or common vestibule and lateral incisions at each extremity. On reflection of the skin and panniculus the cloaca and penis are seen to be enclosed by a circular arrangement of muscle constituting the internal or proximal sphincter of the vestibule and penis. Distally this is related to the external sphincter, dorsally with the anterior caudal muscles, and proximally it is connected to the pubic symphysis by a longitudinal structure of muscle. Passing ventral to its proximal portion and closely attached to the fascia and panniculus is a muscle on each side traceable to the corresponding tibia where it is inserted, with a muscle coming from the lateral and dorsal surface of the proximal sphincter and front of tail. These leg adductors, the former of which lies ventral to Cowper's gland on each side when equally opposed, would appear to aid copulation by their "steading" effect. The proximal sphincter is the factor compelling the penis, enlarged owing to the engorgement of its vascular spaces, to become extruded. This is aided, of course, by relaxation of the external distal sphincter, and of the sphincter to which the preputial sheath is attached. The shortening of the stretched band of voluntary muscle within the body of the penis, together with the collapse of the engorged vascular spaces, are the factors causing a return to the normal state. To understand the mechanism of which the openings of the penis and vasa deferentia are approximated, it is necessary to saw

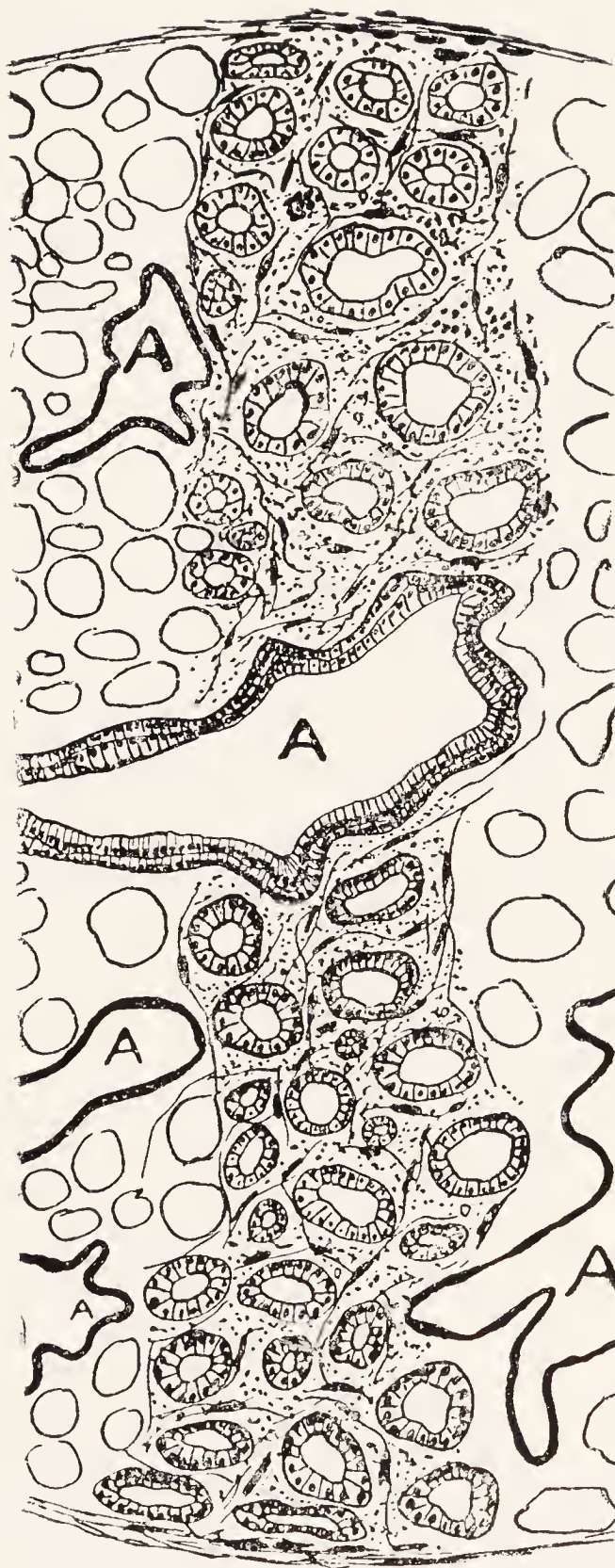


Fig. 24

SECTION THROUGH COWPER'S GLAND. MALE PLATYPUS.

The Ducts (A) are seen to be lined by Columnar Stratified Epithelium, and the Vesicles by Columnar Epithelium. The important difference between this gland and the human Cowper's is that in the latter there is a large amount of interlobular connective tissue.

PLATYPUS AND ECHIDNA.

through the pubic symphysis and divaricate the divided portions. By so doing, the urogenital canal is brought into view. Attached to this is a longitudinal layer of muscle contractor, extending from the beginning of the penis distally to the loose tissue about the front of the bladder proximally. From the beginning of the penis a band of muscle, retractor, passes out on each side, becoming attached to muscle fibres, passing from the pelvis to the anterior caudal regions, being traced to the vertebrae.

Structure of the Penis.—A section through the body of the penis shows a dense fibrous enveloping capsule with fibrous ground substance in which numerous large and small blood sinuses are embedded. The single urethral channel is also embedded in a fibrous stroma. Opposite to the urethra is a thick-walled artery and a voluntary muscle funiculus which is traced along the body of the penis, but is not traceable to the glans penis.

A section through the distal portion of the glans penis shows four divisions of the urethra, surrounded by dense fibrous tissue in which numerous large and small blood sinuses are present. The whole is enveloped by stratified epithelium which has a dense stratum corneum. No voluntary muscle is present. The ducts are lined by stratified epithelium.

Cowper's Glands.—These are two in number, one on each side, and are well defined, measuring 2.25 cm. in greatest length and 1.5 cm. across. They lie at the lower or distal border of the gracilis muscle near its pubic origin, between the base of the penis and the mesial part of the thigh. Their secretion is carried by a fine duct about 3 cm. long to the penile urethra at its commencement. They can be felt from the surface by making pressure about 1 cm. lateral to the distal extremity of the pubic symphysis. These are compound alveolar glands, the alveoli being lined by columnar cells. The ducts of the alveoli, which drain into the common duct, are lined by columnar stratified epithelium.

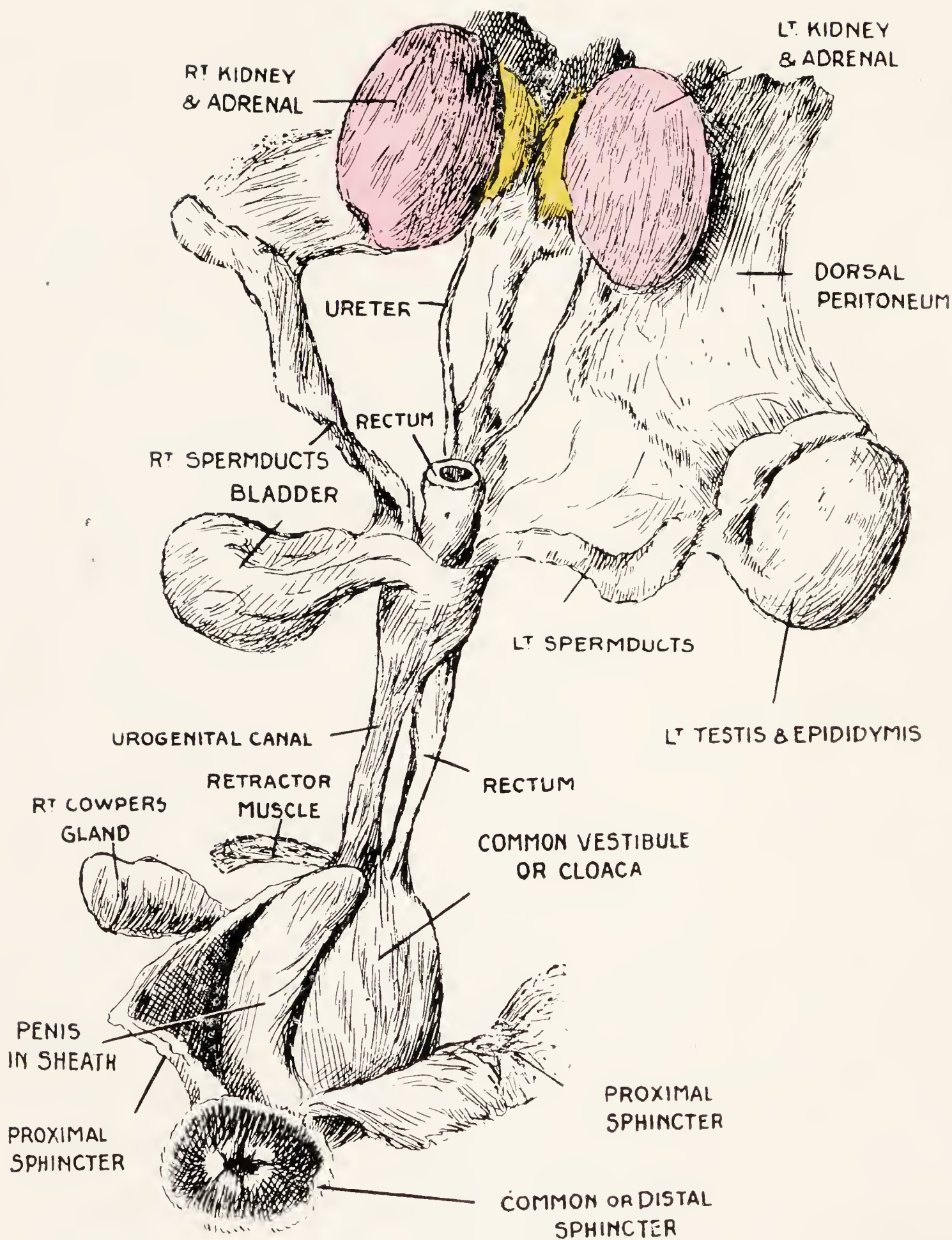


Fig. 25

THE GENITO-URINARY SYSTEM IN MALE PLATYPUS.

PLATYPUS AND ECHIDNA.

(b) ECHIDNA.

The general arrangement of the male genital system in Echidna is similar to Platypus. The following modifications are worthy of notice :—

(a) There is relatively less mobility of the broad ligament and testes in Echidna, and the upper or outer attachment of the broad ligament is related to the lower and outer border of the kidney. The epididymis or prominent mass of convolution of the vas is more elongated than in Platypus, and measures 1 cm. long and 1 cm. across. The vas deferens becomes simple 1.25 cm. from its termination in the urogenital canal. Generally speaking, the testes are smaller than in Platypus, and we have seen an instance where they were anchored dorsally—that on the left side being related to fixed distal colon, spleen and kidney.

(b) The entrance of ureter and vas is more proximal to the bladder than in Platypus.

(c) The opening in the vestibule for protrusion of the penis is more distal than in Platypus, being really on the sphincter externus.

(d) The glans penis is smoother than in Platypus, and measures 3 cm. long and 1 cm. wide. By means of three small dorso-ventral grooves the extremity of the glans penis is divided into four portions or processes, each of which shows a depression on which a terminal branch of the penile urethra opens.

(e) The penis opens into the urogenital canal 1 cm. from its termination in the vestibule, and its total length is about 3.5 cm.-4 cm.

(f) Cowper's glands are present, but are smaller than in Platypus, and measure 1.75 cm. in length and .75 cm. across.

THE MALE GENITO-URINARY SYSTEM IN MARSUPIALIA.

GENERAL DESCRIPTION.

In the Marsupial the structure of the genito-urinary system approaches that of the higher mammals. Compared with the Monotremes, the following are the important points for consideration :—

(a) The testes are no longer intra, but extra abdominal.

(b) The ureters enter the bladder at its base instead of entering the urogenital canal distal to the bladder orifice.

(c) In relation with the proximal portion of the urogenital canal (proximal urethra), there is a large development of prostatic gland tissue.

(d) In relation with the urethral canal more distally two to three pairs of well-defined glandular structures are noted.

(e) The penis serves for the transmission of both urine and seminal secretion.

Testes.—These are two in number, and measure in *Trichosurus* 5 cm. in greatest length and 1 cm. in greatest width. In *Koala* greatest length is 2.75 cm., and in *Phascolomys* 3.75 cm. Though contained within the abdomen at the time of birth, they soon become extra abdominal after the transference of the embryo to the pouch. Each is contained in a scrotal sac, and they lie ventral to the pyramidalis muscle at the lower portion of the abdominal wall between the two epipubic bones, thus lying proximal to the penis. The testes bear a distinct resemblance to those of Monotremes, the epididymis being loosely attached by peritoneum to the testicular body. There is no outstanding difference between the intra-abdominal and extra-abdominal testis. The organ is



Fig. 26

MARSUPIAL TESTIS AND EPIDIDYMIS (Trichosurus).

At E the Cord is shown in the patent canal.

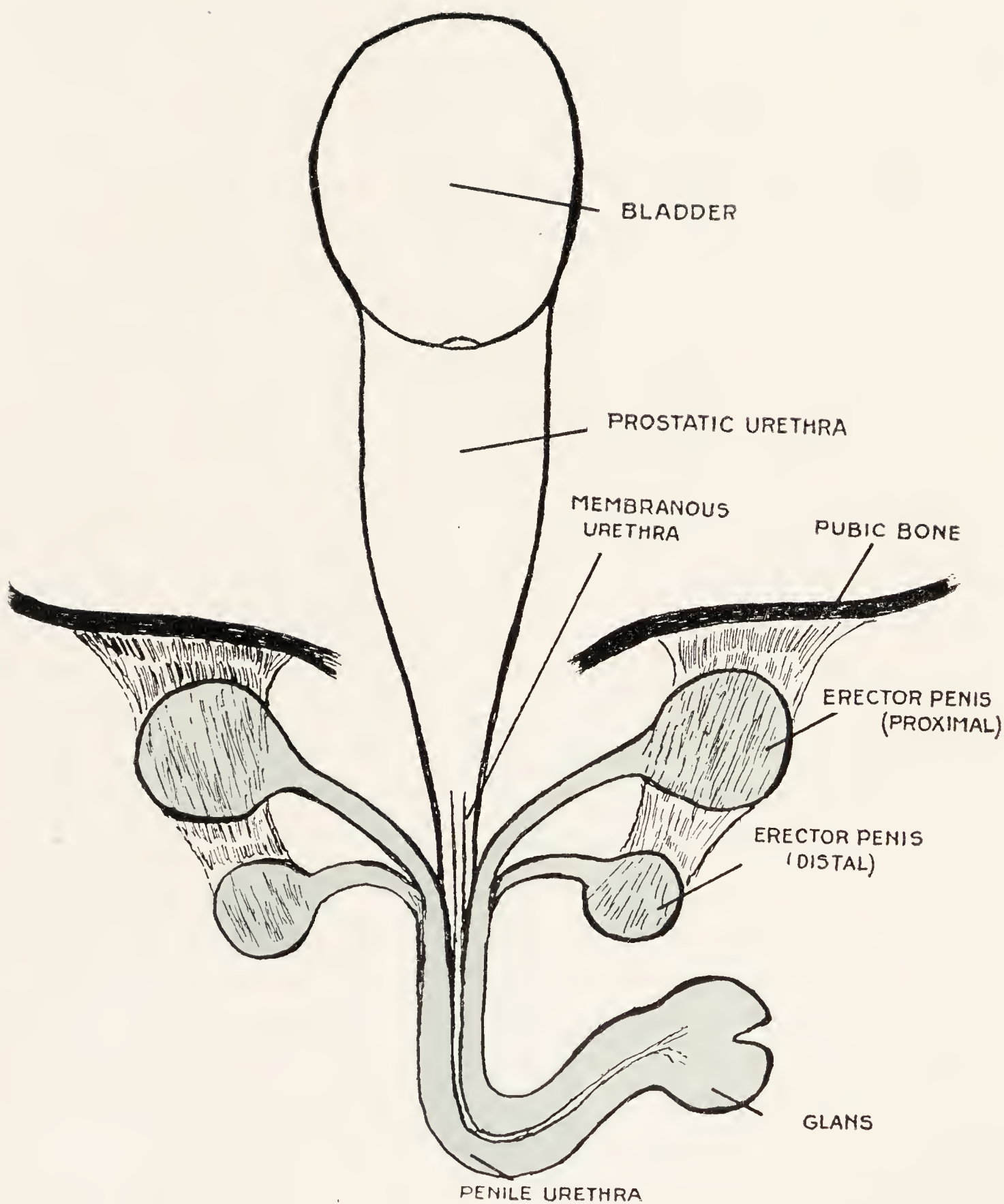


Fig. 27

DIAGRAM TO ILLUSTRATE THE GENITO-URINARY SYSTEM IN
MALE MARSUPIAL.

Upper or Ventral View.

MARSUPIALS.

large in the root-eating Wombat, but relatively small in the carnivorous Tasmanian Devil. The epididymis (convoluted efferent ducts), after looping round the testicle, is continued on as the sperm duct, which, with its vessels and surrounded by the well-developed cremaster muscle, is traced to the inguinal region external to the distal portion or attachment of the marsupial bone. The sperm duct or vas deferens is traced through the abdominal wall, lying in what is termed the inguinal canal—the external opening of which is known as the external abdominal ring, and the internal as the internal abdominal ring. In contrast with Man, both these rings are patent, and a free communication is seen to exist from the peritoneal cavity to the tunica vaginalis. The vas is traced downwards and inwards across the brim of the pelvis to terminate, surrounded by prostatic tissue, in the proximal portion of the urethra about 5 cm. distal to the bladder opening. The length of the vas in *Trichosurus* is 20 cm., 10 cm. being extra abdominal and 10 cm. intra abdominal. The origin of the cremaster muscle on each side is seen to be from the internal oblique and transversalis muscles, so that a gap is formed on the lower abdominal wall, surmounted by the arched fibres of the internal oblique and transversalis muscles. As the cremaster in the Marsupial is a much more developed muscle than in the human, it acts as a powerful accommodating stay or support over the inguinal region, thus obviating the risk of hernia, for which there would be a liability in the Marsupial owing to the fact that a communication exists from the peritoneal cavity to the tunica vaginalis. The liability should be especially in the saltatorial Kangaroo, but there is no instance on record of either the Kangaroo or other Marsupial being found herniated. The seminal vesicles have not made their appearance at this stage of mammalian evolution, which is probably explained by the existence of a breeding season.

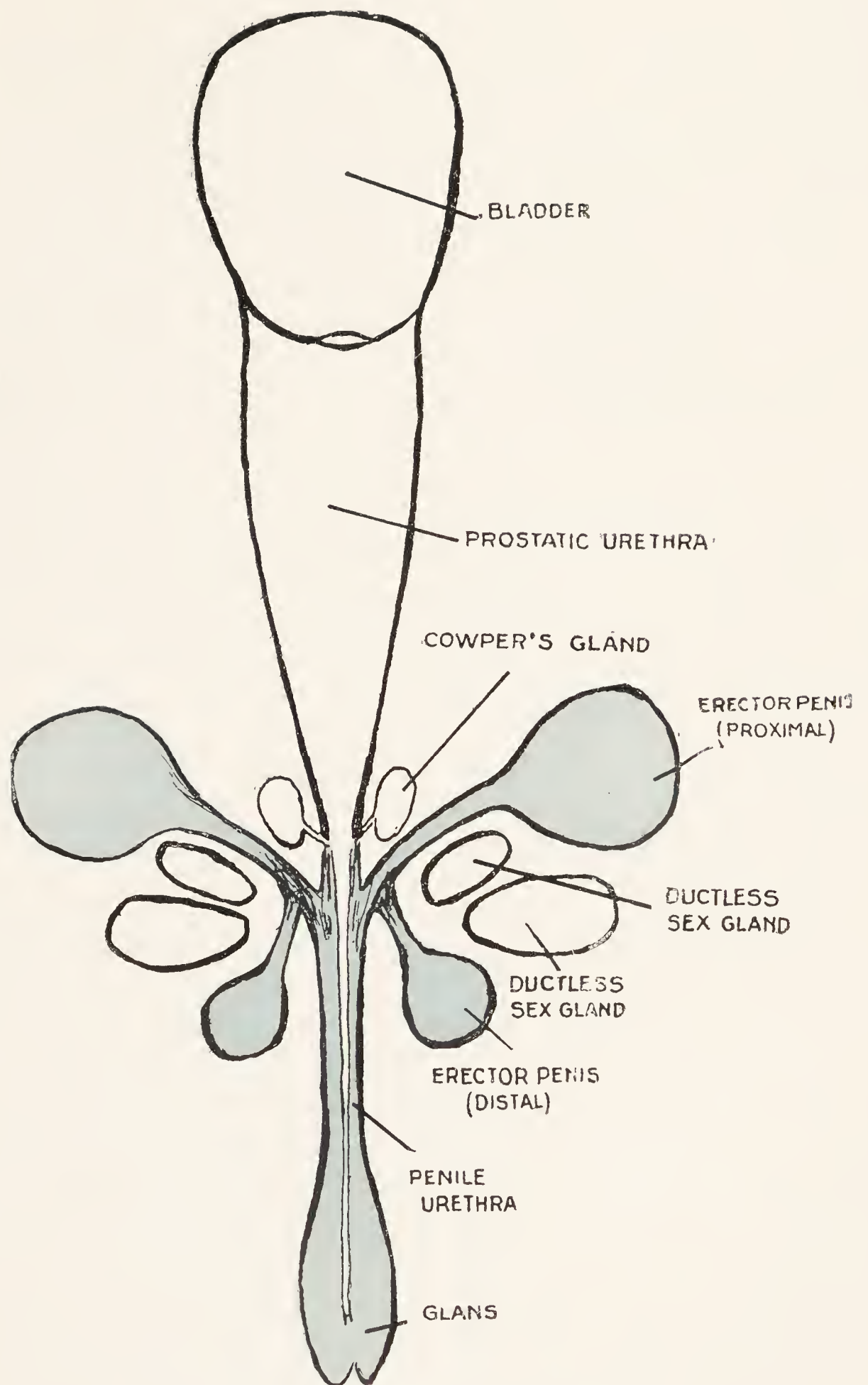


Fig. 28

DIAGRAM TO ILLUSTRATE THE MALE GENITO-URINARY
SYSTEM IN MALE MARSUPIAL.

Under or Rectal View.

MARSUPIALS.

Bladder.—Speaking generally, there is greater mobility in the bladder of Marsupials than in that of Man. In the Monotremes the ureters from the kidney open in the urogenital canal distal to the bladder orifice, but in the Marsupials they open just within the orifice of the bladder. We have never found urine in the bladder of Platypus, and the suggestion is offered that not only does the muscular sac serve as a reservoir for the urine, but it may act also as a regulator or pace-maker for the genito-urinary tract.

Proximal or Prostatic Urethra. Prostate Gland.—The genital tract of the Marsupial is characterised by the development in relation with the proximal portion of the urethral tract (which is the name applied to the genito-urinary tract between the neck of the bladder and termination of the penis, and the total length of which in *Trichosurus* is 12 cm.) of prostatic gland tissue. This structure first makes its appearance in Marsupials, and, although it is traced throughout the Mammalia up to Man, it reaches its highest relative development in this order also. In Man the prostate is frequently described as a bilateral structure originally, and that the lateral portions have approached to enclose the urethral channel. By a study of the Marsupial light is thrown on the development of this gland. It must be regarded as a development of glandular tissue in the wall of the proximal portion of the urethral tract. The prostate gland, as such, cannot be dissected from the channel contained within it. The proximal or prostatic urethra would be best described, then, as an elongated cone, broad and thick proximally, and tapering distally. The channel itself is narrow, slightly wider at its proximal portion where it receives the vas deferens on either side than distally, and presents longitudinal folds. A section through the middle of the prostatic urethra shows a centrally situated channel lined by transitional epithelium; the great thickness of the wall is due to the presence of glands (prostatic)

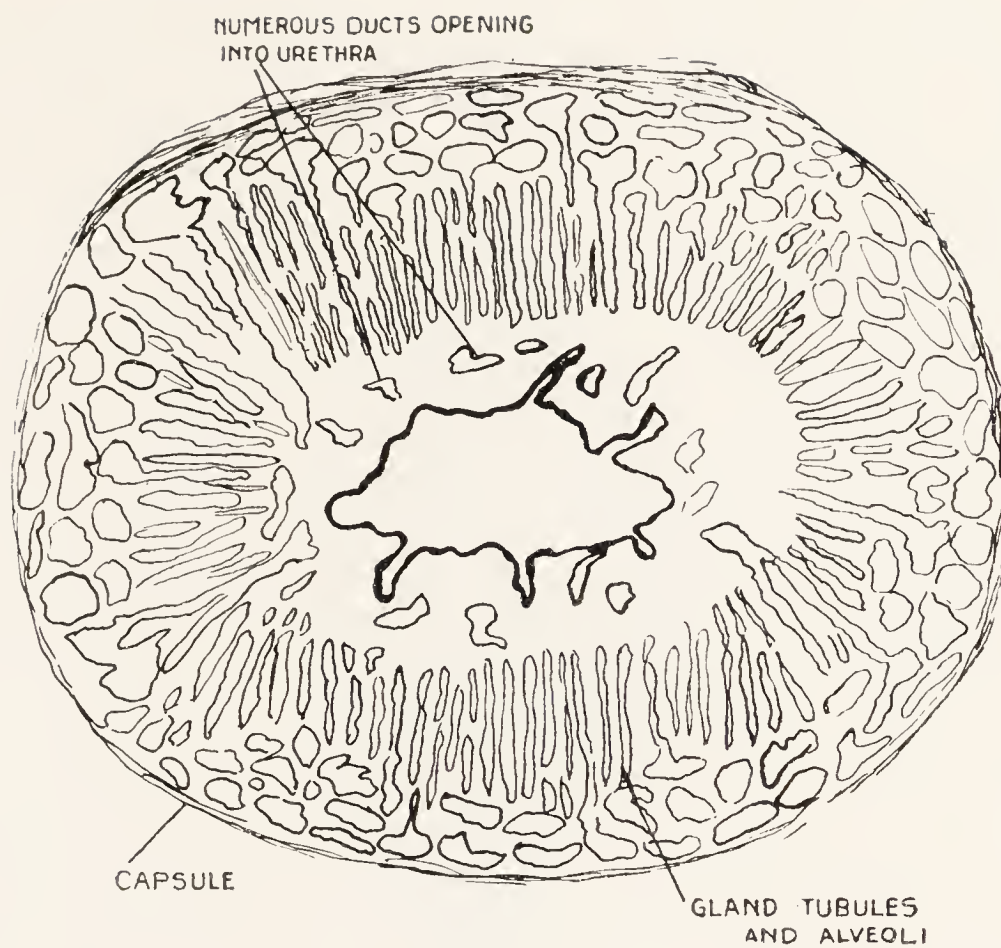


Fig. 29

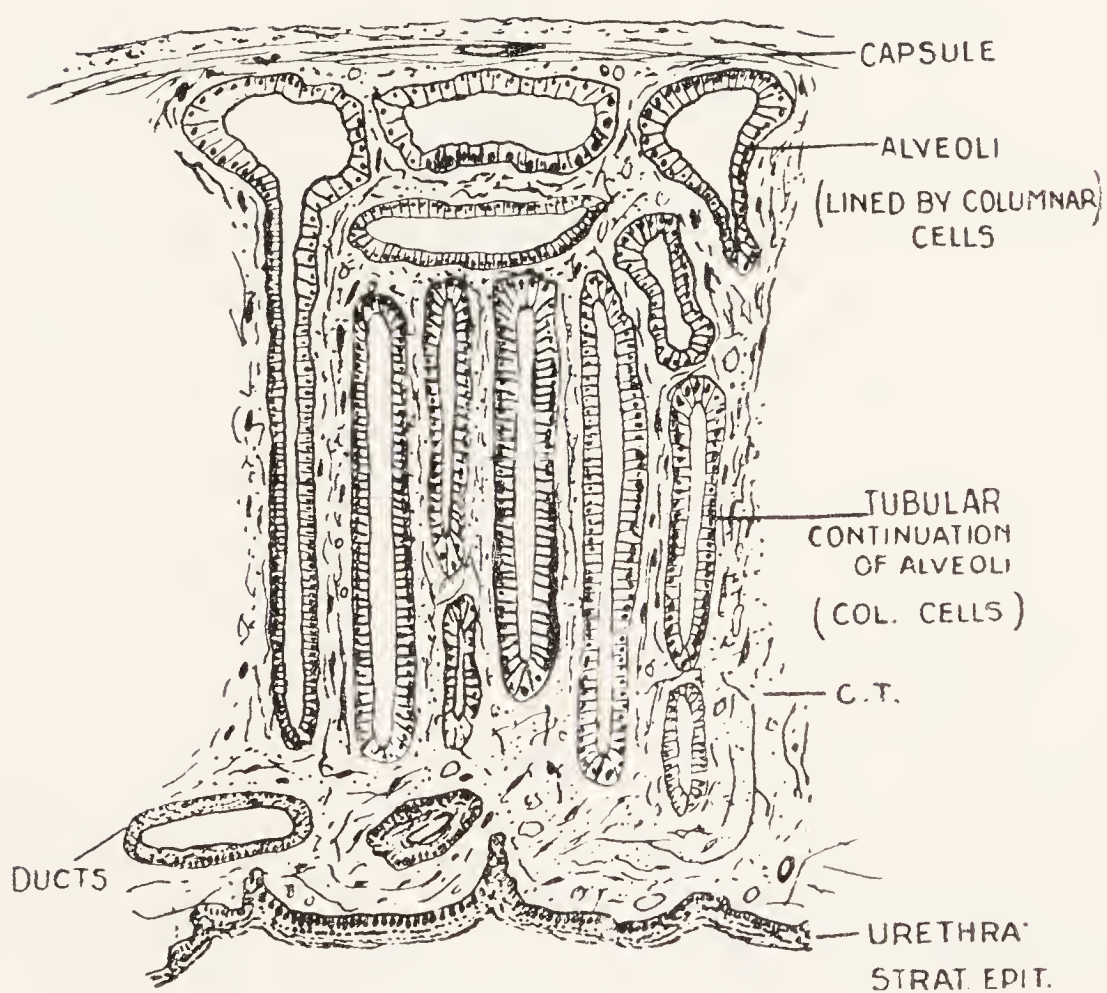


Fig. 29a

THE MICROSCOPIC ANATOMY OF THE PROSTATIC URETHRA IN MARSUPIAL.

MARSUPIALS.

of the compound tubulo-alveolar type lined with low columnar cells. These communicate with numerous ducts which open into this portion of the urethra, and are lined with columnar cells, which may be two-layered (columnar stratified). Externally, we have a tough tunica propria in which a small amount of involuntary muscle is noted. The prostatic urethra lies dorsal to the symphysis pubis, and in *Trichosurus*, in which animal prostatic gland tissue is best developed, an average length would be 4-5 cm. In one *Trichosurus*, however, of average size we found the greatest length was 8 cm., width 5 cm., and depth 3.75 cm.

Membranous Urethra.—The prostatic portion of the urethral canal is succeeded by a narrow portion from which the tubulo-alveolar glandular structure is absent. In an adult *Trichosurus* this portion measures 1.75 cm., and in width .5 cm. The canal here is wider than that of the prostatic portion, and the longitudinal folds noted in the previous portion are present, and are continued on to the penile portion. The lining membrane is composed of transitional epithelium, and this is surrounded by a broad connective tissue layer or tunica propria external to which are two layers of voluntary muscle. External to the muscle is an adventitious layer of connective tissue with blood vessels.

Penile or Cavernous Urethra.—The urethral canal becomes now firm and thickened for a distance in the case of *Trichosurus* of 4-5 cm., owing to the fact that the channel wall is surrounded, not as in the case of the proximal portion by a tubulo-alveolar, but by a fibro-vascular (elastic and erectile tissue) casing. This casing is formed by two lateral portions which unite mesially at the upper and lower surface of the urethra in *Trichosurus*. Distally they are continued on the glans penis, but proximally they are seen to diverge for a distance of about 1 cm. on each side, to pass into a bulb of voluntary muscle containing

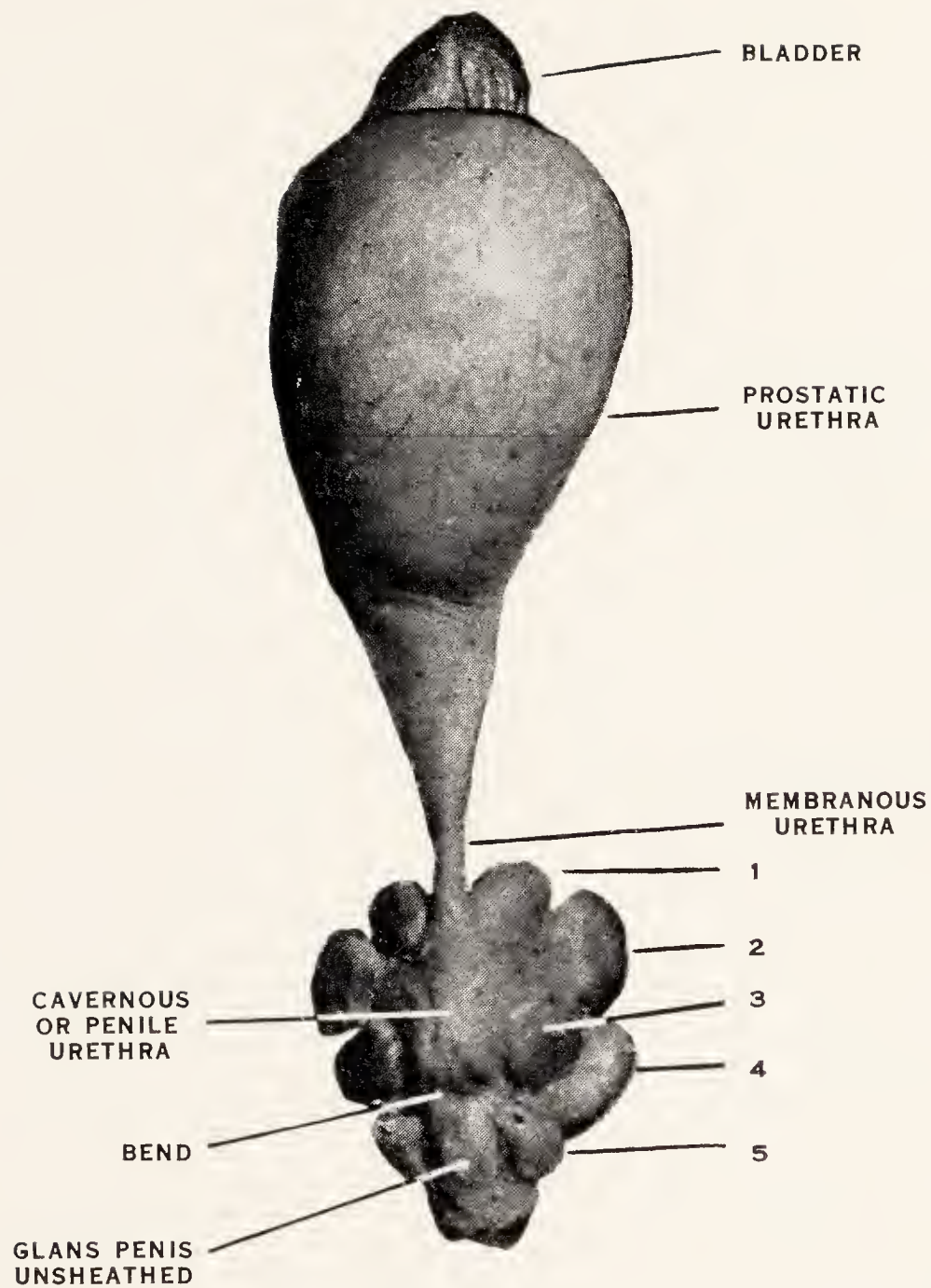


Fig. 30

DISSECTION TO SHOW GENITO-URINARY SYSTEM.
MALE PHALANGER. *Trichosurus*.

1 Ductless "Sex" Gland. 2 and 3 Erectores Penis (Muscular).
4 and 5 Sebaceous Glands (No. 4 removed on right side).
The Distal Pair of Ductless Glands is not seen on this aspect.

MARSUPIALS.

erectile tissue in its interior on each side (erector penis), and this bulb is connected by a band of tough fibrous tissue to the pubic bone. These lateral portions or cavernous bodies might be regarded as the tendons of these muscular bulbs, and on their under surface just before their junction to encase the urethra, each is joined by a band of fibro-erectile tissue, which is traced to a smaller more distal bulb of voluntary muscle tissue (erector penis), and this latter is also connected to the pubic bone by a fibrous band. The smaller or distal muscular bulb contains in its interior erectile tissue of a relatively greater amount than the larger muscular bulb, and the sheath of which is less fibrous. These are the muscular factors concerned in the elongation or erection of the penis. Their antagonists are the retractores penis, two muscular bands about .75 cm. wide traced from the glans penis distally along the sides and dorsum of the penis to the middle of the sacrum proximally. Aiding elongation of the penis, a muscular band is noted from the junction of the two main cavernous bodies to the pubic symphysis, and a narrow muscular strip is noted connecting the two bodies before their junction. The width of the cavernous urethra is .75 cm., and the interior presents, like the preceding portions of the urethra, longitudinal folds. It is narrower at its commencement than distally owing to thickening of or promontory-like projections from the mucous membrane. In the ordinary relaxed or passive state this portion of the urethra in the marsupial is bent on itself so as to form a V shape. This is maintained by a fibrous band which has to be divided to unravel the penis for purposes of examination. The exception is the Tasmanian Devil. A section through the middle of this portion of the urethra shows the channel in the interior lined by stratified epithelium and surrounded by erectile sinusoids similar to the corpus urethrum of the human penis. Further out, surrounding the upper or ventral and the lateral surfaces,

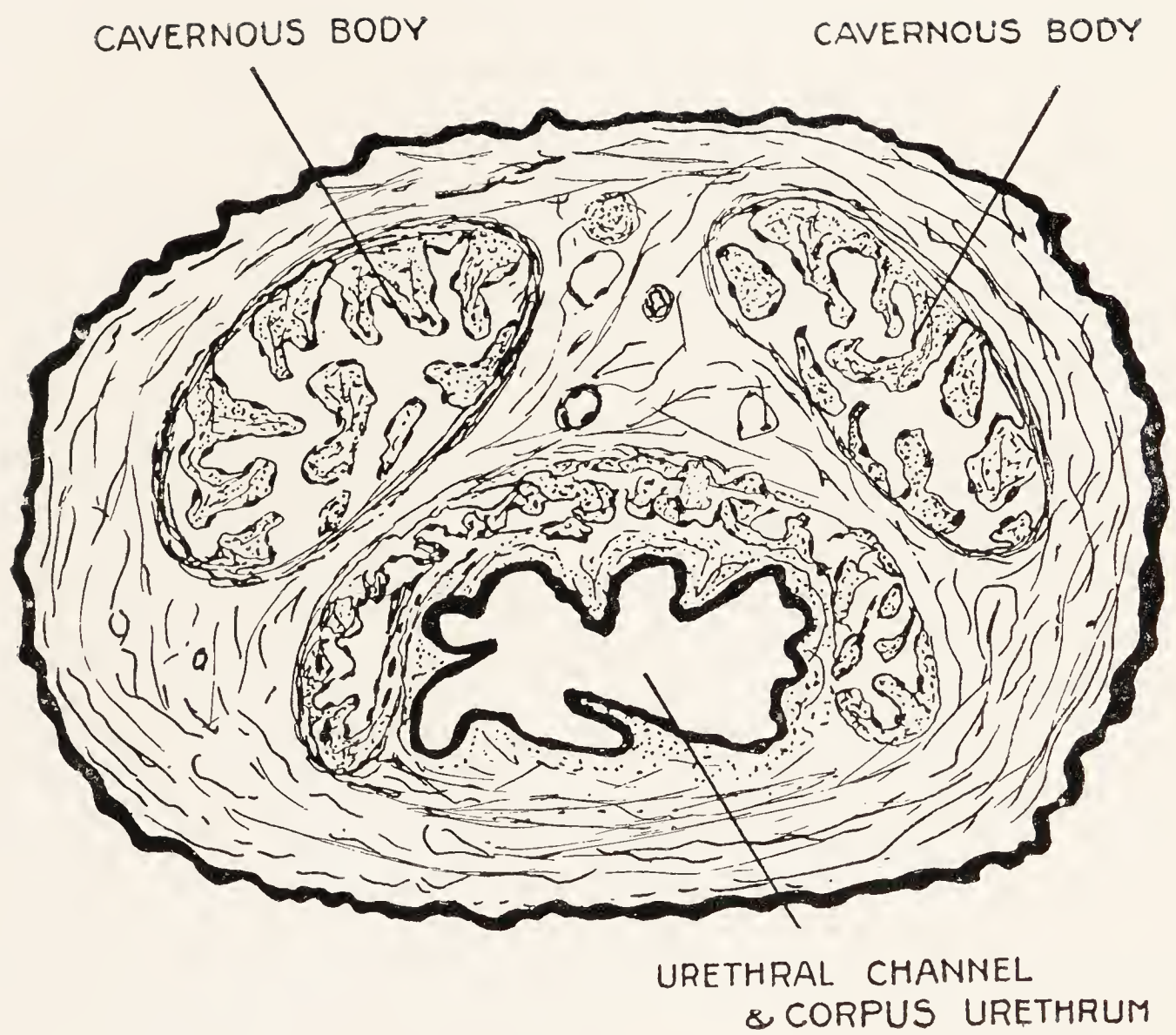


Fig. 31

SECTION THROUGH MIDDLE OF PENIS. AUSTRALIAN PHALANGER.
(Trichosurus).

MARSUPIALS.

other erectile sinusoids will be found embedded in fibrous and elastic connective tissue, but on the under or dorsal surface dense connective tissue devoid of sinusoids is found. In the Wombat and other Marsupials where the urethra is near the surface, as in the human, little connective tissue is found on this under surface. Externally, the section shows an outer protective stratified epithelium, much keratinised. No voluntary muscle is seen.

Glans Penis.—The urethra is finally enclosed within the shorter, wider, and less rigid glans penis. In *Trichosurus* this measures 1.5 cm. long, with greatest width of 1.25 cm., and the surface is studded with papillary projections. The urethral channel is widest here, and at the extremity of the glans a blunt, fibrous, horn-like projection is noted about .5 cm. long. Within the common cloacal orifice two openings are seen—the dorsal or rectal, and the ventral containing the glans penis enclosed within its preputial sheath. A section through the middle of the glans penis in *Trichosurus* shows the channel lined by stratified epithelium; this is surrounded on three sides by erectile tissue sinusoids (*corpus urethrum*), but on one side a *corpus cavernosum* is seen, *i.e.*, a body formed of a fibrous and elastic capsule enclosing sinusoids. Then, externally, we have a sheath of connective tissue and stratified epithelium. In *Koala* a section through the middle of the glans penis shows, instead of a single, two *corpora cavernosa*, one on each side, and the enveloping stratified epithelium shows long keratinised filiform papillae.

Glandular Bodies.—If we examine the under surface of the penis in *Trichosurus*, *i.e.*, from the rectal aspect, a remarkable series of twelve glandular-like structures are seen, six on each side, with the rectum forming a septum between them. The most distal ones, *i.e.*, towards the cloaca, of which there are two on each side, are sebaceous



Fig. 32

SECTION THROUGH GLANS PENIS. AUSTRALIAN PHALANGER.
(Trichosurus).

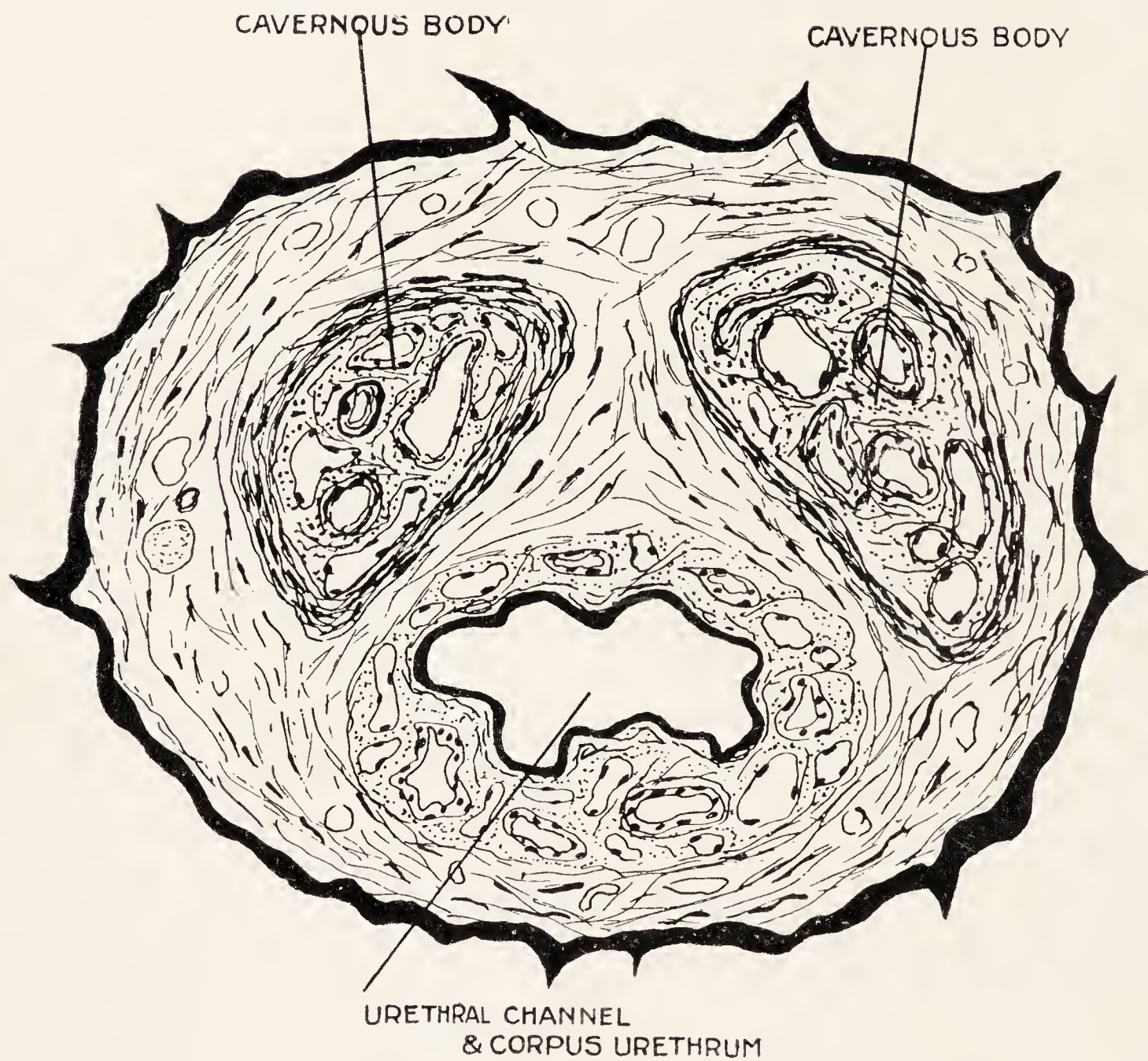


Fig. 33

SECTION THROUGH GLANS PENIS. KOALA.
(Phascolarctus Cinereus)



Fig. 34

SECTION THROUGH DUCTLESS MARSUPIAL "SEX" GLAND,
surrounded externally by voluntary muscle.

This specimen is from Australian Phalanger (*Trichosurus*).

MARSUPIALS.

glands in connection with the rectal termination. The largest and most lateral on each side is the mass of voluntary muscle already described (proximal erector penis), from which the two corpora cavernosa arise. Distal to this on each side, *i.e.*, between it and the sebaceous glands, is a smaller voluntary muscular mass whose fibro-erectile tendon was described as connected to the under surface of each corpus cavernosum before its connection with its fellow to embrace the urethra. The proximal erector penis mass measures 1.75 cm. in length, 1.5 cm. in greatest breadth, and 1 cm. thick. On the inner or mesial aspect of the proximal muscular mass two glands are noted on each side between it and the rectum; the proximal one is the larger and paler, measuring 1.5 cm. long, 1 cm. wide, and .75 cm. thick, while the smaller darker and more distal measures 1 cm. long, .75 cm. wide, and .5 cm. thick. These are *not* Cowperian glands. They are ductless, and show similar structure to the sex gland described by us in the male and female Platypus, *i.e.*, each is a vesicular gland, the vesicles being lined by columnar cells, and containing a viscid secretion.

WOMBAT.

The cremaster muscle in connection with the extra abdominal portion of the cord is well developed. In spite of the disparity in size between the two animals, the size of prostatic urethra rarely exceeds that of Trichosurus. An average length in Wombat would be 5 cm. long, 3 cm. greatest width, and 2.5 cm. in depth. The membranous urethra measures 1.75 cm. long, and the average length of the penis, when unfolded, from the apex of the prostatic portion to the tip of the glans is 10 cm. The termination of the urethral channel is bifid, and horny spicules are present on the surface of the glans.

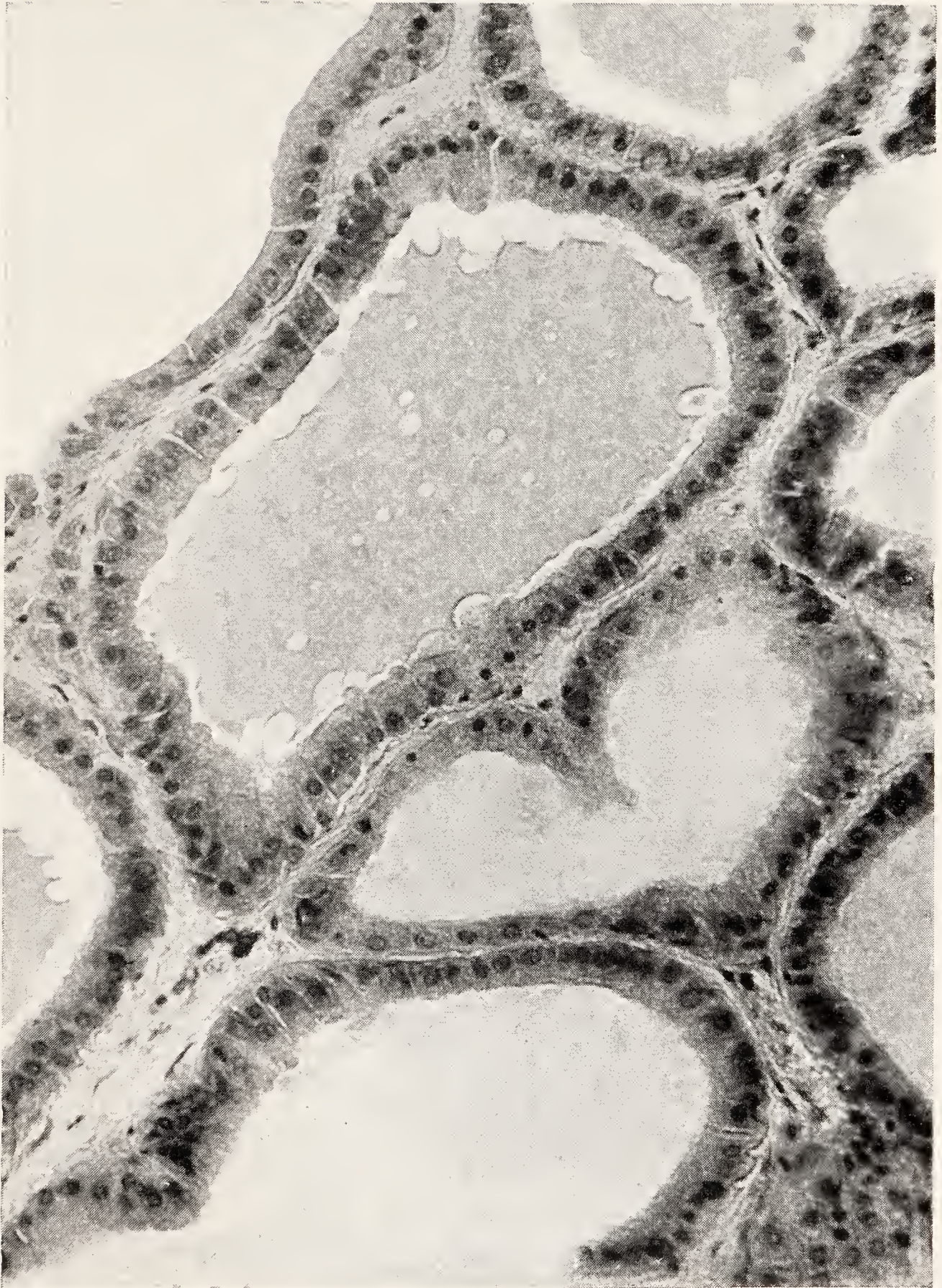


Fig. 35

SECTION CERVICAL SEX GLAND, High Power, MALE PLATYPUS.
Micro. Photograph.

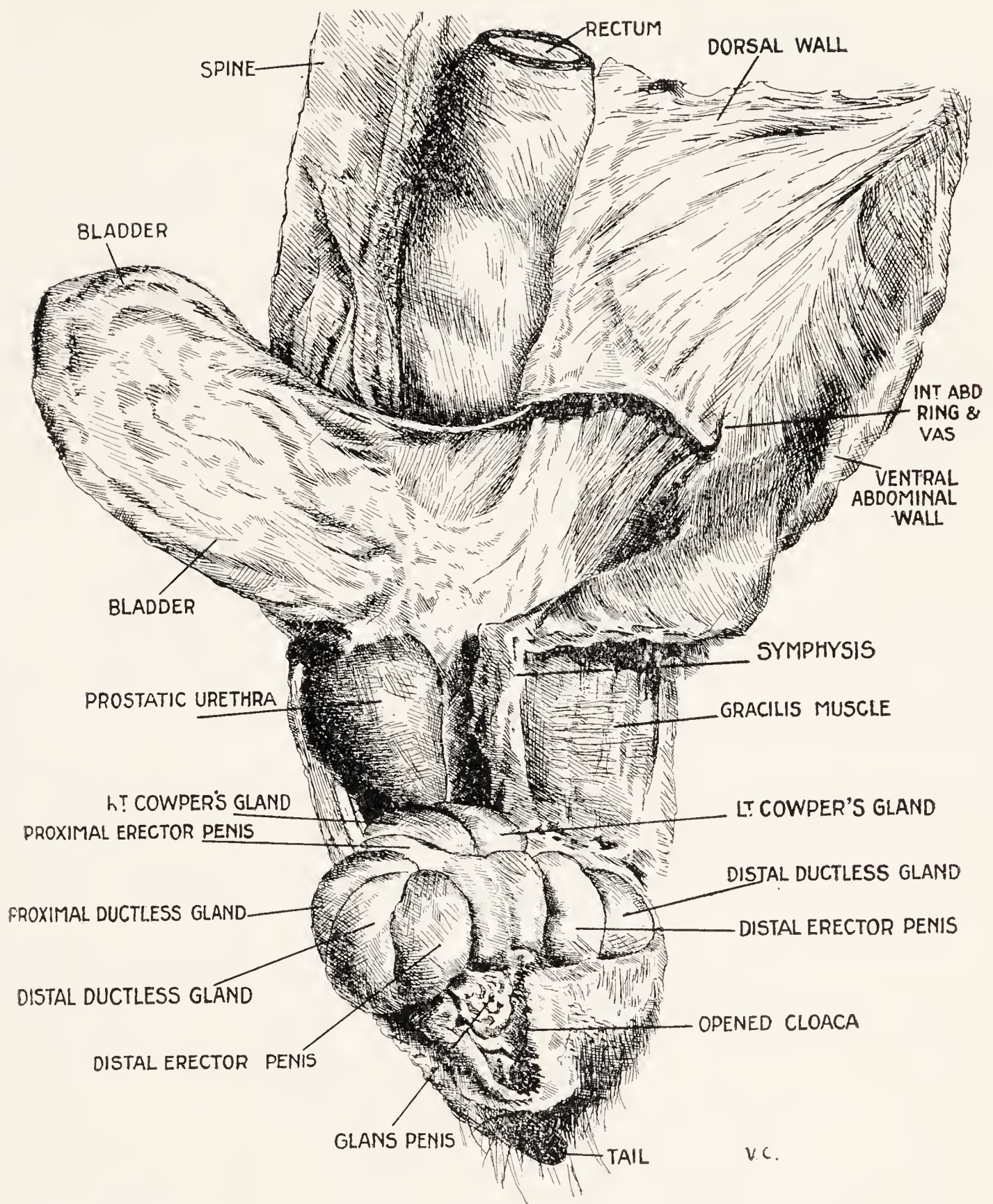


Fig. 36

DISSECTION TO SHOW RELATIONS IN SITU OF GENITO-
URINARY ORGANS. MALE WOMBAT.

(The Right Pelvis has been removed). The Proximal Ductless Gland and Proximal Erector Penis are not shown on the left side.

MARSUPIALS.

Glandular Bodies.—As in the case of *Trichosurus*, certain glandular-like bodies are met with when the penile urethra is examined from its rectal surface. We distinguish, as in the *Phalanger*, distally two pairs of sebaceous glands, also on each side the proximal or larger, and distal or smaller muscular masses (*erectores penis*). The proximal one measures 3-5 cm. in greatest length, and 3 cm. greatest width, and the distal and more ventral one 3 cm. in length and 2 cm. wide. In addition, three pairs of glandular bodies are seen, instead of two as in *Trichosurus* (*a*), (*b*), and (*c*).

(*a*) This is most proximal, and lies on each side of the membranous urethra, just proximal to the junction of the corpora cavernosa. Each measures 3 cm. long, 2.5 cm. greatest width, and 1 cm. in thickness. Each is a compound tubulo-alveolar gland corresponding to Cowper's gland in *Platypus* and *Man*. The ducts open in the urethra about the junction of the penile and membranous portions.

(*b*) More distal to the preceding and seen on the rectal, aspect only, is a somewhat flatter gland on each side, narrow towards the urethra. This measures 2.5 cm. long, 2.5 cm. in greatest width, and 1 cm. in thickness.

(*c*) More distal to (*a*) and (*b*) is on each side a large rounded gland. This measures 3.5 cm. in greatest length, 2.5 cm. in greatest breadth, and 2.5 cm. in thickness. These latter pairs of glands, (*b*) and (*c*), are of the ductless variety, and correspond to the sex gland found in *Platypus*. Each is a vesicular gland; the vesicles are lined by columnar cells, and contain the same type of viscid secretion as in *Platypus*.

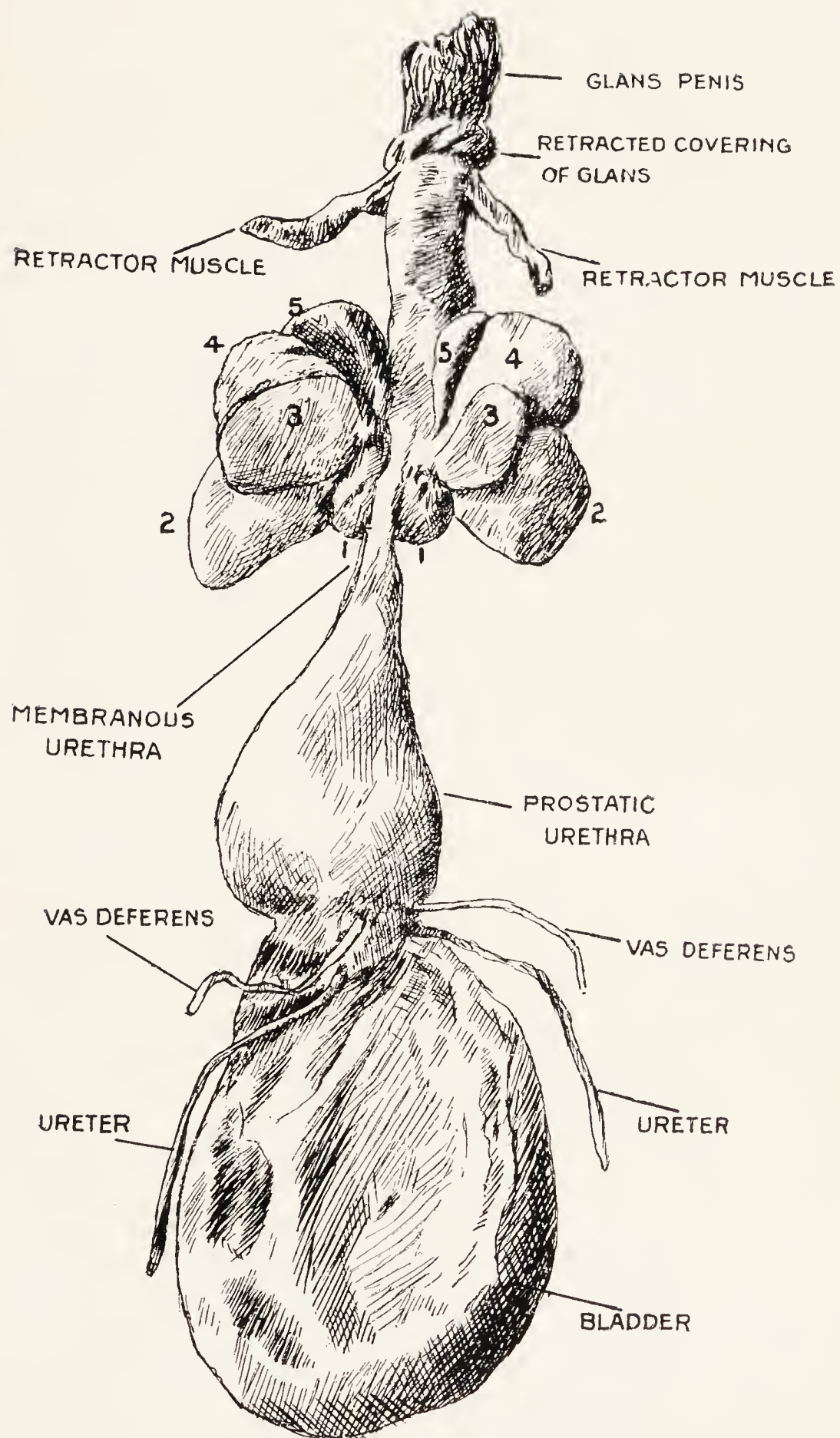


Fig. 37

THE BLADDER AND URETHRAL TRACT IN VICTORIAN WOMBAT.
(*Phascolomys Mitchelli*).

1 Cowper's Glands. 2 Proximal Erectores Penis. 3 Ductless "Sex"
Glands. 4 Ductless "Sex" Glands. 5 Distal Erectores Penis.

MARSUPIALS.

KOALA.

Here the prostatic urethra is not so large as in *Trichosurus*, *Wombat*, or *Kangaroo*. An average measurement is 3 cm. in length, 2 cm. wide, and 1.75 cm. in depth. The membranous urethra measures 2 cm. long, and the penis is bifid at its termination. On examining the under or rectal surface of the penis, in addition to the sebaceous glands and the large and smaller muscular masses (*erectores penis*), only two pairs of glandular bodies are met with, and not three as in *Wombat*. The proximal gland on each side is the smaller and flatter, and measures 1.75 cm. in greatest length and 1.5 cm. in greatest breadth. The distal gland on each side is the larger and more rounded, with a greatest length of 2.5 cm. Both pairs of glands are ductless, and show histologically vesicles lined by columnar cells. They correspond to the sex gland of *Platypus*.

TASMANIAN DEVIL.

In this Marsupial the testes are small and rarely measure more than 1.5 cm. long and 1 cm. in width. The cremaster muscle is poorly developed, and the inguinal canal is closed. The prostatic urethra is poorly developed, being long and narrow measuring 3-3.5 cm. in length and .75 cm. across. The membranous urethra measures 2.5 cm. long, with a width of .25 cm. On examining the under surface of the penis, in addition to the sebaceous glands, which are well developed, and the bilateral masses of voluntary muscle (*erectores penis*), two pairs, as in *Koala* and *Trichosurus*, of poorly developed glandular structures are noted. Each of the proximal pair measures .75 cm. in length and .5 cm. across, and each of the distal and more rounded pair measures .5 cm. in length and .25 cm. across. Both pairs of glands are ductless and correspond to the sex gland of *Platypus*. The extremity of the penis is not contained within a cloacal sphincter, as in other Marsupials,

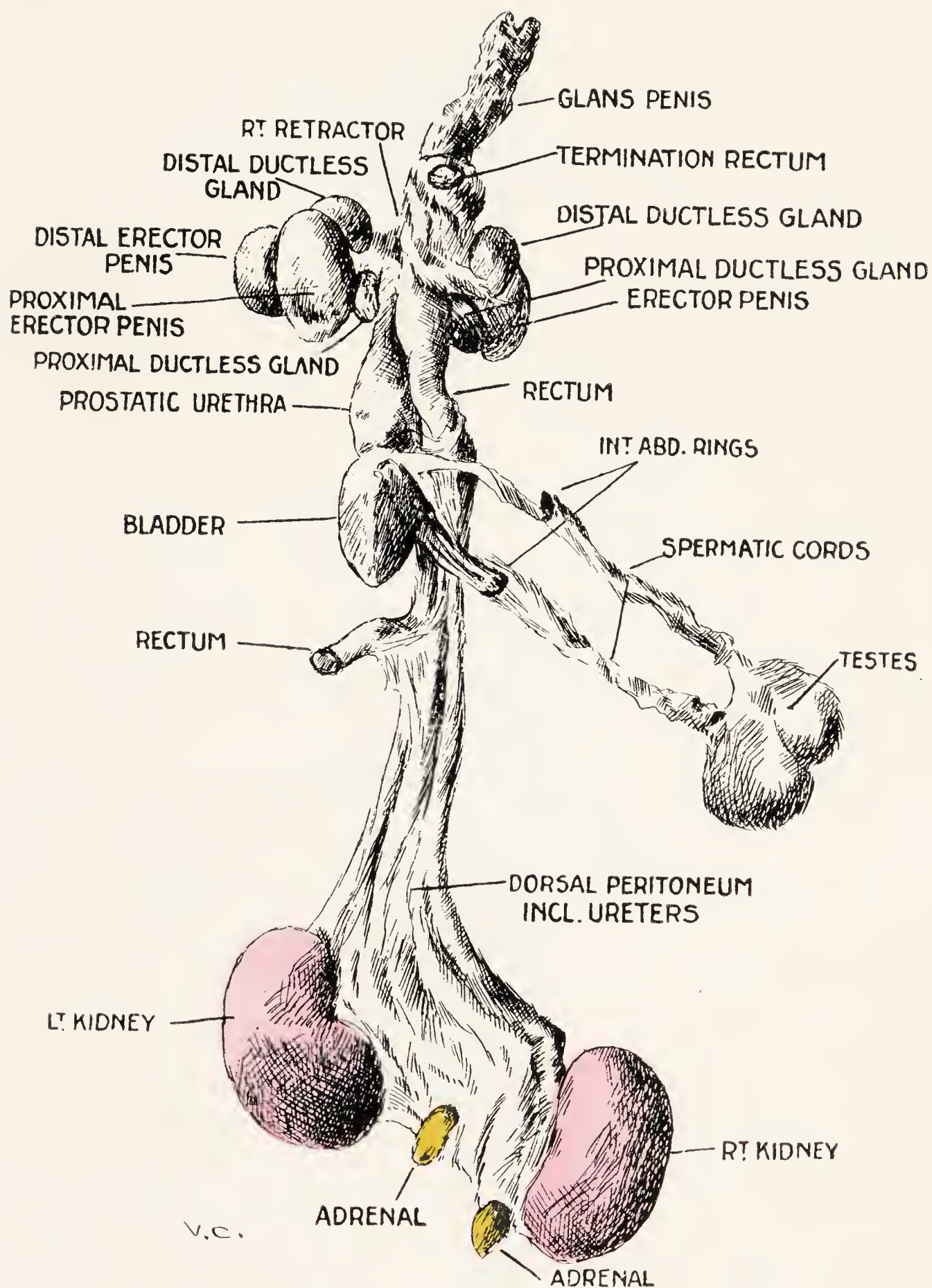


Fig. 38

DISSECTION TO SHOW THE GENITO-URINARY SYSTEM IN
MALE KOALA (*Phascolarctus Cinereus*).

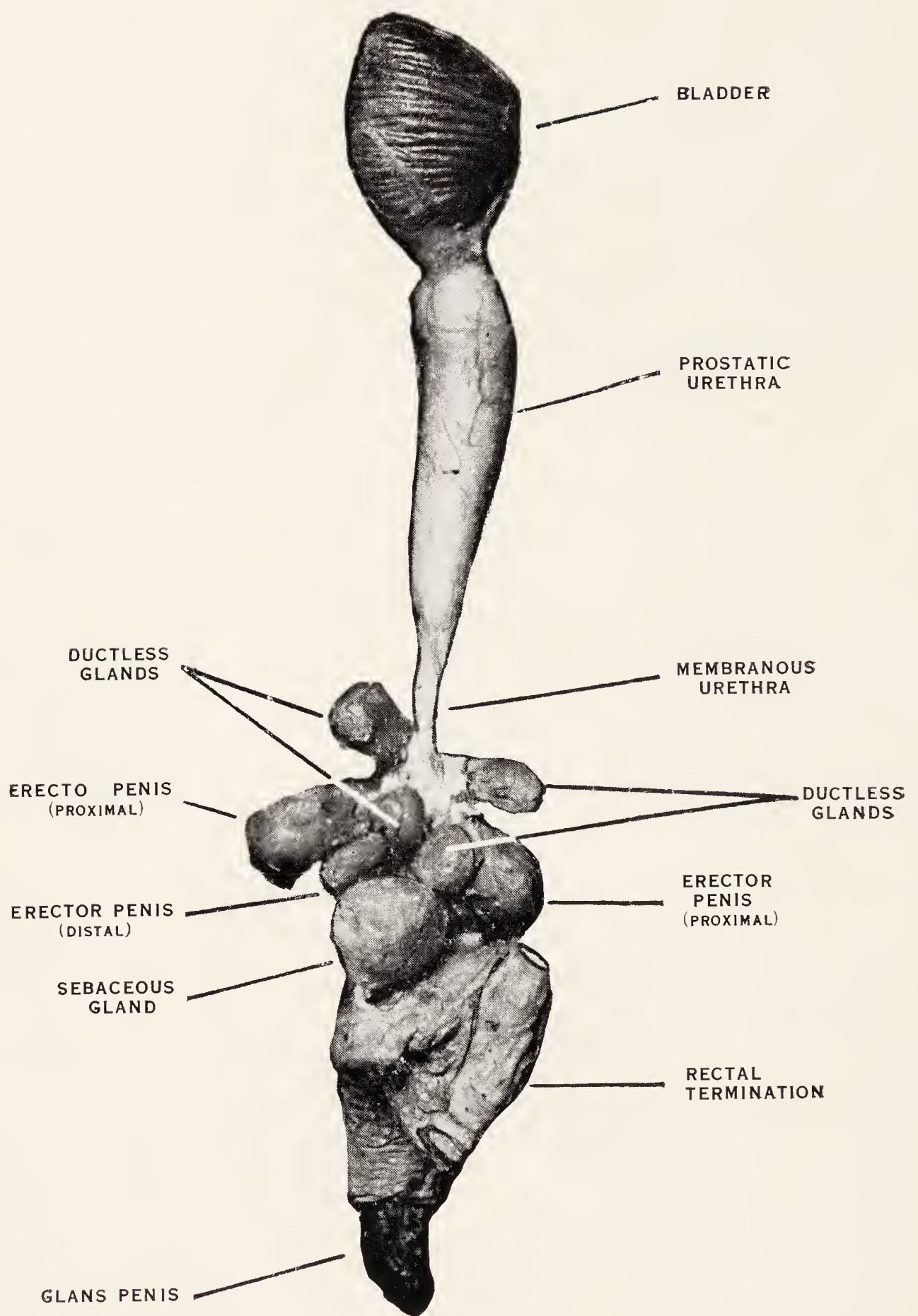


Fig. 39

THE BLADDER AND URETHRAL TRACT IN MALE
TASMANIAN DEVIL (*Dasyurus Sarcophilus*).

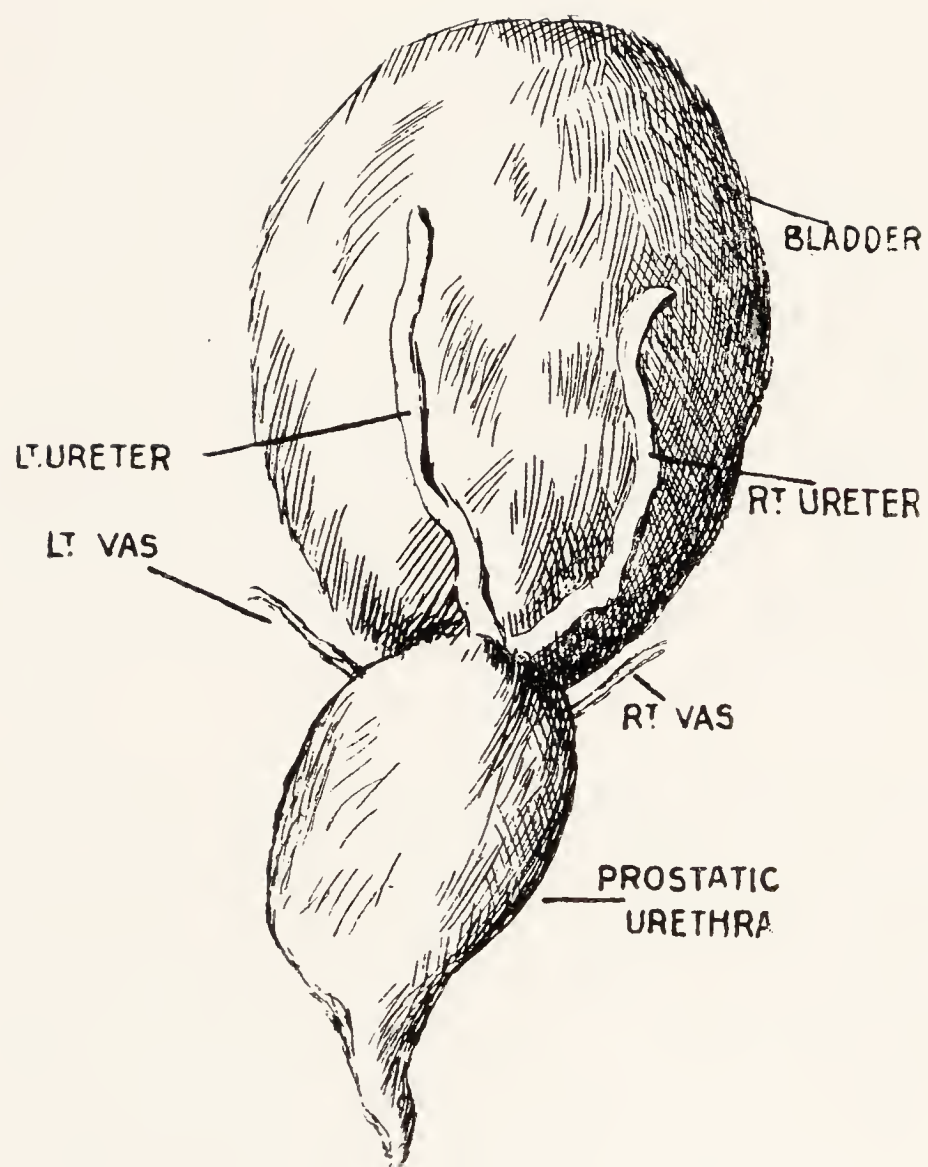


Fig. 40

BLADDER AND PROSTATIC URETHRA. KANGAROO.
(Macropodidae).

MARSUPIALS.

and projects externally for about 2.5 cm. beyond the rectal termination, 1 cm. being glans and the remainder penile urethra. The glans is smooth, and the width about .75 cm. In contrast to the other Marsupials there is practically no bend in the penile portion of the urethra.

MACROPODIDAE. KANGAROOS AND WALLABIES.

In Kangaroo the prostatic urethra is well defined, and may measure 6.5 cm. in greatest length, 4 cm. in greatest width, and 2.75 cm. in thickness. The glans penis is narrow and pointed, and measures 1.5 cm. in length. On examining the under or rectal surface of the penis, in addition to the sebaceous glands, and voluntary muscle masses previously described as characteristic of Marsupials, three glandular bodies are met with on each side (*a*), (*b*), (*c*), as in Wombat, although in comparison they are feeble developments.

(*a*) This is proximal, and placed one on each side of the termination of the membranous urethra just proximal to the junction of the corpora cavernosa, and is best seen from the upper or ventral aspect. Each measures 1 cm. in greatest length and .5 cm. in greatest width. As in Wombat, this is a compound tubulo-alveolar gland, and corresponds to Cowper's gland seen in Wombat, Platypus, and Man.

(*b*) This is distal to (*a*), and is a flat gland, one on each side, measuring 1.5 cm. in length, .75 cm. greatest width, and .5 cm. thick.

(*c*) This is most distal and smaller than preceding, each measuring 1.5 cm. in length, .25 cm. wide, and .25 cm. thick. Both pairs of glands (*b*) and (*c*) are ductless, being composed of vesicles lined by columnar cells, and correspond to the sex gland met with in Platypus.



